O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

J1647-02-01
August 9, 2019

Joseph Laydon
Town of Grafton
30 Providence Road
Grafton, Massachusetts 01519

Re: Peer Review Comments
Brigati Village Slope Project
41 Church Street
Grafton, Massachusetts

Dear Mr. Laydon:

O'Reilly, Talbot & Okun Associates, Inc. (OTO) is pleased to provide this letter report summarizing our geotechnical engineering peer review comments for the proposed Brigati Village development, to be located at 41 Church Street in Grafton, Massachusetts.

We based our review on the following documents:

- Design sheets prepared by WDA Design Group, dated February 7, 2019 (revised May 17, 2019) entitled Special Permit/Site Plan Approval for Brigati Village;
- Geotechnical Engineering Report, Slope Stability Evaluation – Brigati Village, by Northeast Geotechnical, Inc., dated May 15, 2019;
- Geotechnical Engineering Report Addendum #1, Slope Stability –Brigati Village, by Northeast Geotechnical, Inc., dated July 12, 2019; and
- Slope Stability Analyses, performed by Northeast Geotechnical, Inc., provided in electronic format.

Project Description

The project consists of the construction of 10 multi-unit apartment buildings at the south end of West Street in Grafton, Massachusetts. The project includes the construction of three storm water basins; two detention basins in the western part of the Site (west of proposed Buildings Nos. 5 and 6) and an infiltration basin in the eastern part of the Site (to the east and northeast of Building No. 3). Each basin will be located at the top of a slope and will involve the placement of fill to form an embankment on the downhill side of the slope. Approximately 10 to 12 feet of fill will be placed to form the embankment on the west (downhill) sides of Detention Basins Nos. 1 and 2. Approximately 10 feet of fill will be placed to form the embankment on the east side of the Infiltration Basin No. 3. The filling of the slopes for the two detention basins appear to be the critical design case since the downhill fill slope is steeper (3 horizontal on 1 vertical) than the downhill slope around the infiltration basin (which is 4 horizontal on 1 vertical).

The configuration of the embankment can be seen on Sheet C5.04 (upper left corner) of the Site Plan Approval package by WDA. The embankment will be constructed of

impervious fill, which will be keyed into the native glacial till to limit seepage through the embankment. Water levels within each of the detention basins will be controlled via an outlet control structure and a riprap lined overflow swale. Water exiting the control structures flows through a system of piping and manholes before empting into the riprap lined drainage swales downhill of the embankments. The locations of the control structures, associated pipes and riprap lined swales are shown on Sheet C3.02. Surface water is eventually discharged to the ground surface, via riprap lined spreaders approximately 80 to 120 feet to the west of the detention basins.

We note that the detail provided on Sheet C5.04 does not depict actual construction details. As depicted on Sheet 3.02 below the embankment the solid drainpipe flows through drain manholes and eventually discharges through a flared end section. The solid pipe from Basin 1 flows through three manholes and eventually discharges into the level spreader approximately 120 feet to the west of the basin. The solid discharge pipe from Basin 2 flows through one manhole and discharges into the riprap lined swale to the southwest of the basin.

Soil and Groundwater Conditions

Northeast Geotechnical, Inc. (NEG) performed subsurface explorations, laboratory analyses and slope stability analyses for the embankment on the west sides of Detention Basins Nos. 1 and 2 in the western part of the Site. They performed three soil borings during January 2019 to evaluate subsurface soil and groundwater conditions. The subsurface location plan provided by NEG is attached. These explorations indicated that existing soil conditions consist of a topsoil layer, followed by a relatively thin fine to medium sand (subsoil), underlain by glacial till. Glacial till is a dense to very dense, heterogeneous mixture of silt, clay, sand and gravel, which was deposited at the base of the continental glaciers which once covered all of New England. Because the glacial till was subject to very high vertical pressures from the weight of overlying ice sheet it is typical very compact and is stable at relatively steep slopes. Given the high density and relatively high silt and clay content, it is also relatively impermeable, causing groundwater to flow near the top surface of the glacial till layer.

We note that project plans call for the removal of the topsoil and fine to medium sand subsoil layers prior to construction of the embankment fills. Therefore, this layer will be ignored during analyses.

NEG encountered glacial till at a depth of between 2 and 5 feet below ground surface in their soil borings. Groundwater was present at a depth of between 3 and 4 feet below ground surface in a groundwater observation well installed and monitored by NEG. Therefore, it appears that under natural conditions groundwater flows along the top of the Glacial Till layer.

NEG also completed a laboratory testing program on selected samples of the Glacial Till. This program consisted of grain size distribution analyses, the completion of the compacted maximum dry density via the Modified Procter method (ASTM D1557) and the determination of the soil shear strength (friction angle and cohesion intercept). The laboratory data indicates that the material contains between approximately 20% and 50%

silt and clay (and thus is relatively impermeable) and can be compacted into a relatively dense state (as evidenced by a relatively high maximum dry density of 139.5 pounds per cubic foot). The laboratory direct shear test indicated a relatively high friction angle of 42.7 degrees.

Slope Stability Analyses

NEG performed slope stability analyses of the 3H to 1V embankment slope to the west of Basins 1 and 2. A limit equilibrium analyses was performed using the SLOPE/W computer program using the Morgenstern-Price Method. Three stability analyses were performed:

- Static analysis with the groundwater table at the surface (conservative analysis);
- Static analysis with the groundwater table at the glacial till surface; and
- Pseudostatic analysis under seismic loading with the groundwater table at the glacial till surface.

We note that some design cases described in the US Army Corps of Engineers Manuals (such as rapid drawdown) are applicable to flood control levees along riverbanks, and are not applicable to this project.

A discussion of model parameters, slope geometry, analyses conditions and factors of safety against failure is provided below. The computational output files are attached to this report.

Slope Geometry and Soil Profile

The slope geometry used in the model was based on a section cut to the west of Basin 1, as shown on the attached Subsurface Exploration Location Plan provided by NEG. NEG assumed a soil profile of a compacted, structural fill over the natural glacial till. It was assumed that the topsoil and fine to medium sand subsoil would be entirely removed. The assumed soil profile and geometry appear to be reasonable, although we recommend that a geotechnical engineer be present during construction to document that the topsoil and fine to medium sand subsoil have been removed as discussed in the Recommended Construction Documentation section below.

Soil Properties for Slope Stability Analysis

NEG uses the following soil properties in their analyses:

Property	Compacted Structural Fill	Glacial Till
Unit Weight (pcf)	133	133
Friction Angle (degrees)	38	42
Cohesion (psf)	0	0

These values appear to be reasonable based upon published values, the laboratory testing performed, and our experience.

Groundwater Modeling

The location of the groundwater table and groundwater seepage forces have a significant impact on the stability of embankment slopes. To address this issue the embankment design calls for the placement of impervious backfill (likely recompacted glacial till from the Site) to form the embankment and the keying of the impervious fill into the natural glacial till layer. This detail is appropriate to prevent seepage through the embankment, and thus increasing the stability of downslope soils. We understand that compacted structural fill will be placed downslope of the impervious embankment core. Given the design of the embankment, significant seepage forces are not anticipated and were not included in the analyses. We concur with NEG's groundwater modeling.

NEG analyzed stability with two assumed groundwater conditions. They performed an analysis assuming the groundwater table would be present at the ground surface downhill of the embankment, and a second analysis with the groundwater table present along the top of the glacial till layer. The first is conservative since it assumes that water will leak through the impervious core. In our opinion, this is unlikely given the design detail and impervious nature of the embankment core and underlying glacial till. The second analysis is more reasonable since it assumes conditions similar to those that are occurring currently, with only limited leakage through the embankment.

Seismic Loading Parameters

In addition, NEG performed a pseudostatic stability analysis to assess the factor of safety against slope failure subjected to earthquake forces. NEG indicates that the ground acceleration used in the analysis was based upon the seismic parameters for the Town of Grafton obtained from the 9th Ed. Massachusetts State Building Code. The 0.14 seismic coefficient used within the pseudostatic stability analysis appears appear appropriate.

For this analysis, the groundwater table was assumed to be at the glacial till surface. As discussed above, this appears consistent with the proposed design.

Recommended Minimum Factors of Safety and Discussion of Results

For general slope stability, NEG computed a factor of safety of 1.3 for the conservative analysis with the groundwater at the ground surface, and 1.7 with the groundwater table along the glacial till surface. We compared these values with recommended minimum factors of safety for embankment slopes[1]. The appropriate factor of safety is dependent on the consequences of a failure and the amount of uncertainty associated with the design. The greater the uncertainty in the design and the higher the consequences of the failure, the higher the required factor of safety. In generalized terms, the following values

[1] "Soil Strength and Slope Stability, Duncan, Wright and Brandon, Wiley, 2014, Table 13.1, page 216.

are recommended. For slope stability analyses evaluating seismic events, a Factor of Safety is commonly between 1 and 1.15[2].

Minimum Factor of Safety		
	Small Uncertainty	Large Uncertainty
Limited Consequences	1.25	1.5
Significant Consequences	1.5	2.0

Since no structures are located downslope of the detention basin embankments, and the main consequence of a failure would be that soil and water would flow over the slope downhill of the basins, it is our opinion that only Limited Consequences are likely. The main uncertainty associated with the analyses is the location of the groundwater table downslope of the embankment. The analysis with the groundwater table at the ground surface has only a small uncertainty since placing the groundwater table at the ground surface is a conservative assumption and is unlikely to occur. We have conservatively assigned a large uncertainty to the analysis with the groundwater table along the top of the glacial till layer.

Comparison of the computed and minimum factors of safety are as follows.

Analyses	Computed Factor of Safety	Minimum Factor of Safety
Static Conditions: Groundwater Table at Ground Surface	1.3	1.25
Static Conditions: Groundwater Table at Glacial Till Layer	1.7	1.5
Pseudostatic Conditions: Seismic Event	1.3	1.0 - 1.15

Since the the minimum required value for both analyses it is our opinion that an adequate factor of safety has been achieved.

Design Details Review and Recommended Construction Documentation

We have reviewed the Design Plans developed by WDA Design Group and the geotechnical recommendations provided by NEG in the May 15, 2019 report. Both the design depicted on the plans and the geotechnical recommendations appear reasonable. We provide the following comments:

- We note that the Detention Berm Section presented on Sheet C5.04 is conceptual (for example the solid pipe through the embankment will flow through concrete manhole(s) prior to discharging through the flared end section as depicted on the plans). Therefore, actual conditions will vary.

[2] "Soil Strength and Slope Stability, Duncan, Wright and Brandon, Wiley, 2014, Table 10.1, page 183.

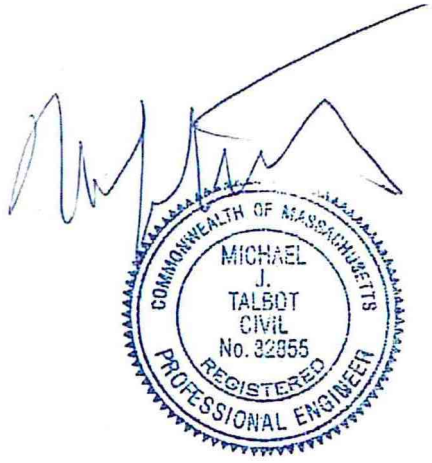
- Following the submittal and testing of the soils to be used as compacted structural fill, the geotechnical engineer should assess whether these soils will meet the geotechnical strength properties assumed in the slope stability analyses.
- The geotechnical engineer should be present during critical portions of the construction to document that the topsoil and fine to medium sand subsoil layers have been removed and that the impervious embankment core has been construction consistent with the project plans.

We appreciated the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Stephen McLaughlin, EIT
Project Manager/Reviewer

Michael J. Talbot, P.E.
Principal



Ashley L. Sullivan, P.E.
Associate/Reviewer

Attachments: Limitations, NEG Subsurface Exploration Location Plan; NEG Geotechnical Report and Addendum #1, Stability Analyses Computational Output; Select Project Plans

APPENDIX A

LIMITATIONS

LIMITATIONS

1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

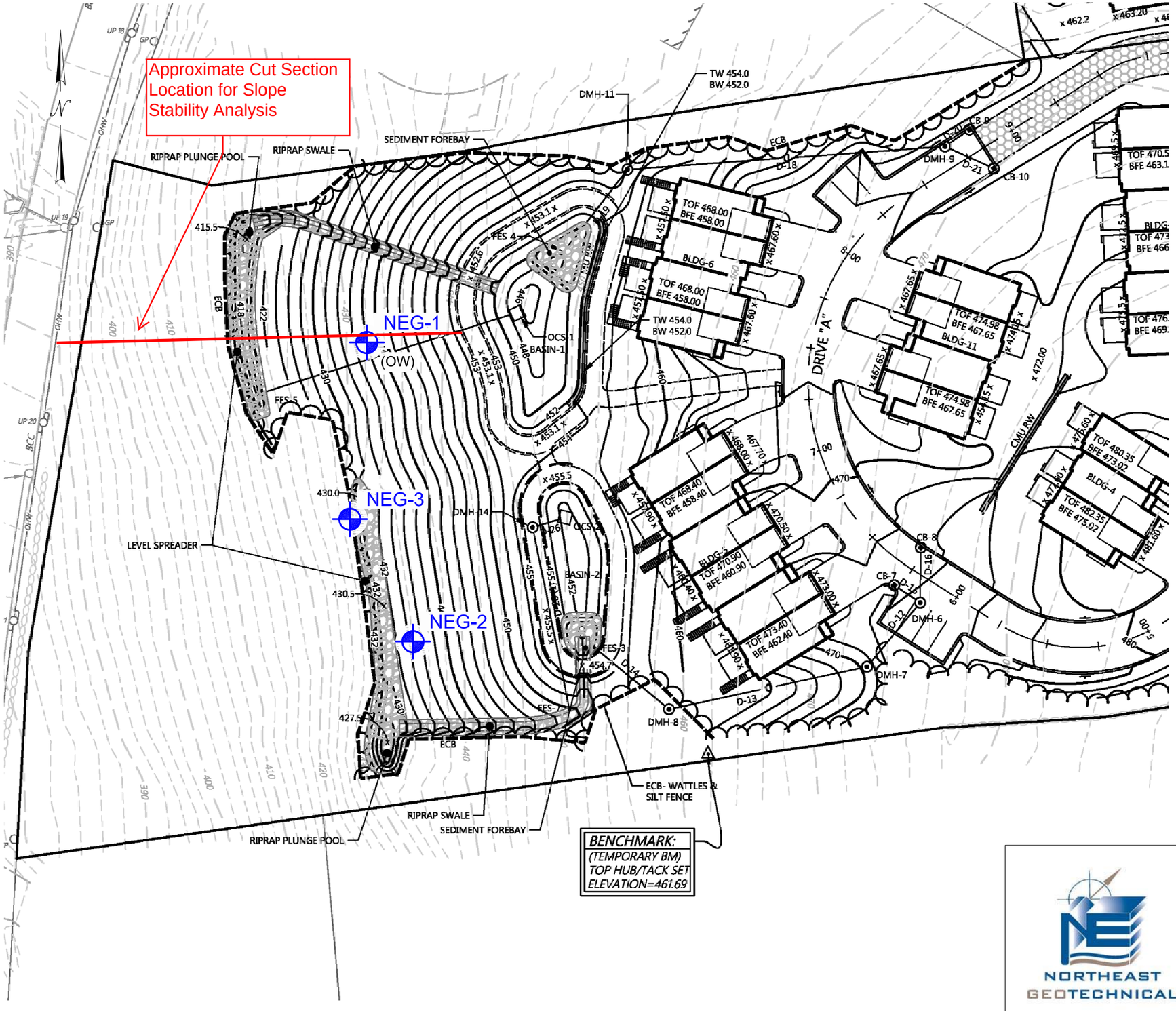
4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

5. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.

APPENDIX B

NEG SUBSURFACE EXPLORATION LOCATION PLAN

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES



NOTES:

1. BASE MAP DEVELOPED FROM PLAN ENTITLED "GRADING AND DRAINAGE PLAN", SHEET C3.02, DATED 2/7/19, BY WDA DESIGN GROUP.
2. THE TEST BORING LOCATIONS WERE SURVEY LOCATED BY WDA DESIGN GROUP PRIOR TO DRILLING. THE TEST BORING LOCATIONS SHOWN ON THIS PLAN SHOULD BE CONSIDERED APPROXIMATE.
3. THE TEST BORINGS WERE OBSERVED AND LOGGED BY NORTHEAST GEOTECHNICAL PERSONNEL.

LEGEND:

TEST BORINGS PERFORMED BY SEABOARD DRILLING, INC. OF SPRINGFIELD, MA ON JANUARY 2 AND 3, 2019.

(OW) GROUNDWATER OBSERVATION WELL INSTALLED AT TEST BORING LOCATION

NORTHEAST GEOTECHNICAL

NORTHEAST GEOTECHNICAL, INC.

BRIGATI VILLAGE

41 CHURCH STREET — GRAFTON, MA

SUBSURFACE EXPLORATION LOCATION PLAN

Project No.: Z331.00	Drawn By: JJP	Reviewed By: M.ZAMBERNARDI, P.E.
Date: 5/12/2019	Scale: 1"=50'	Figure No.: 1

APPENDIX C

NEG GEOTECHNICAL REPORT & ADDENDUM #1

COPY

NORTHEAST
GEOTECHNICAL, INC.
Delivering Practical Engineering Solutions

May 15, 2019

Project No. Z331.00

Mr. David W. Brossi
15 Juniper Lane
Grafton, MA 01519

EXHIBIT 40

SUBJECT: Geotechnical Engineering Report
Slope Stability Evaluation – Brigati Village
41 Church Street, 14 and 15 West Street
Grafton, MA

Dear David:

Northeast Geotechnical, Inc. is pleased to present our report summarizing the results of our geotechnical engineering studies performed in support of the design and construction of the proposed slope located within the westerly portion of the subject site. The objective of our geotechnical engineering services has been to assess the subsurface conditions within the area of the proposed slope, perform geotechnical engineering evaluation and analysis to assess slope stability using the results of the test borings and subsequent laboratory testing, and then develop geotechnical engineering recommendations for use by the project team in design and construction.

Background

Our understanding of the existing site conditions and proposed development is based on our correspondence with WDA Design Group (WDA), our site visits including our presence on-site during the test borings, and our review of the soil evaluator test pit logs and progress plans provided by WDA including:

- "Grading and Drainage Plan", sheet C3.02, dated 2/7/2019, by WDA Design Group

The subject site extends to Church Street to the west and West Street to the north. Most of the site is undeveloped and wooded. The northerly portion of the site at the end of West Street is currently developed with residential properties. The site is sloped with ground surface elevations ranging from about 490± feet within the approximate central portion of the site to about Elevation 380± feet within the westerly portion of the site to about Elevation 460± feet within the easterly portion of the site. Wetlands are located within the easterly portion of the site.

The proposed project includes construction of multi-unit residential buildings (57 units), access roads and driveways, site retaining walls and drainage basins. The focus of our geotechnical engineering studies and this report is the stability of the proposed fill slope located within the westerly portion of the subject site.

The grading of the existing slope in the noted area of the site ranges from about three horizontal to one vertical (3H:1V) to four horizontal to one vertical (4H:1V). The proposed slope will be graded to a three horizontal to one vertical (3H:1V) slope with ground surface elevations ranging from about 455± feet down to about Elevation 418± before blending into the existing slope heading downwards towards Church Street to the west.

Fills ranging up to about 13± feet from existing grades will be required to reach the proposed finish slope grades. The fill thicknesses are anticipated to increase following stripping of topsoil and subsoil prior to the placement of compacted structural fill.

Stormwater basins, designated as Basins 1 and 2 on the referenced Grading and Drainage Plan, are located along the top of the proposed slope. According to WDA, the basins are designed to infiltrate collected stormwater into the underlying soils. The proposed basins range from about 3± to 7± feet in depth.

Exploratory Soil Test Borings

Northeast Geotechnical, Inc. provided WDA with an annotated plan showing the proposed soil test boring locations within the area of the proposed slope. WDA survey located the test borings at the site prior to the test boring contractor's mobilization. The test boring locations are approximately shown on the Subsurface Exploration Location Plan, which is attached as Figure No. 1.

The ground surface elevations at the test boring locations were estimated from the grading plans provided. The ground surface elevations shown on the test boring logs and discussed in this report should be considered approximate.

Northeast Geotechnical engaged Seaboard Drilling, Inc. of Springfield, MA to perform the soil test borings (NEG-1 through NEG-3). The test borings were performed on January 2 and 3, 2019, and were observed and logged by Northeast Geotechnical personnel. The test borings were performed using an ATV mounted test boring rig advancing hollow stem augers to depths of about 30± to 36± feet below the existing ground surface.

Standard Penetration Testing (SPT) was performed during the test borings. The SPT was performed by driving a standard 2-inch outside diameter split spoon sampler up to 24 inches using a 140-pound safety hammer falling 30 inches. The number of hammer blows required to drive the sampler in 6-inch increments is recorded on the boring logs. The sum of the blows required to drive the split spoon sampler from the 6 to 12 inch interval and the 12 to 18 inch interval is defined as the Standard Penetration Resistance of the soil. The SPT was generally performed at 5 foot intervals or less.

The soil samples retrieved in the split spoon sampler during each SPT were visually described in the field using Burmister's soil descriptions as indicated on the attached test boring logs (Appendix B). The inside diameter of the split spoon sampler is 1.4± inches. Therefore, soil samples obtained via SPT do not account for soil fractions in excess of about 1.4± inches in diameter, which may be present in any given strata.

A groundwater observation well was installed in test boring no. NEG-1. The intent of the observation well was to allow measurement of the stabilized groundwater levels over time.

Laboratory Soil Testing

A laboratory testing program was performed to assess the geotechnical engineering characteristics of selected soil samples collected from the test borings. Three (3) representative samples were submitted to Thielsch Engineering in Cranston, Rhode Island. The laboratory testing program included:

- Three (3) sieve analyses to assess soil gradation;
- One (1) modified Proctor compaction test to assess maximum dry soil density and optimum moisture content; and
- One (1) direct shear test to assess soil strength (friction angle, cohesion).

The test results are appended to this report in Appendix C.

General Subsurface Conditions

The general subsurface soil conditions encountered in the test borings consisted of natural topsoil and subsoil deposits underlain by apparent natural glacial till. Apparent perched groundwater was encountered as shallow as about 3± feet below ground surface.

Natural Topsoil: The natural topsoil was encountered in each of the test borings at the ground surface. The topsoil was assessed to be about 1.5± to 2± feet thick and generally consisted of very loose, dark brown, silt with about 20± to 50± percent fine to medium sand, 5± to 35± percent organics (roots, leaves), and up to about 5± to 10± percent fine gravel.

Natural Subsoil: The natural subsoil was encountered in each of the test borings below the topsoil at depths ranging from about 1.5± to 2± feet below ground surface. The subsoil was assessed to be about 0.5± to 3± feet thick and generally consisted of loose to medium dense, tan to brown to light gray, fine to medium sand with about 30± to 50± percent silt, 10± to 20± percent fine to coarse gravel, and up to about 5± to 10± percent organics.

Natural Glacial Till: The natural glacial till was encountered in each test boring below the subsoil at depths ranging from about 2± to 5± feet below the ground surface. The test borings were advanced about 28± to 34± feet into the glacial till strata. The glacial till was assessed to generally consist of medium dense to very dense, gray to light brown to beige, fine to coarse sand with about 20± to 50± percent silt and 10± to 35± percent fine to coarse gravel. Cobbles and/or boulders may be present in the glacial till soils based on the grinding of the augers during drilling, and the presence of rock fragments in some boring samples which may be indicative of cobbles and/or boulders.

Boring nos. NEG-1 and NEG-3 were terminated in natural glacial till. Boring no. NEG-2 was terminated upon refusal to the drilling augers at about 30± feet below ground surface, which may be indicative of boulders or the bedrock surface.

Groundwater: Apparent perched groundwater was encountered in the test borings at depths ranging from about 8± to 11± feet below ground surface at the time of the test borings. Northeast Geotechnical personnel measured the groundwater depth in the observation well installed in boring NEG-1 over a 10-day time frame. Refer to the below table for the measured groundwater depths and associated approximate elevations.

Groundwater Observation Well No.	Date	Depth to Groundwater Below Existing Ground Surface (ft.)	Approximate Groundwater Elevation (ft.)
NEG-1	4/29/2019	3.8±	428±
	5/6/2019	3.2±	429±
	5/8/2019	3.8±	428±
Note: The observation well was purged of groundwater until relatively dry on 5/6/2019. The measurement taken on 5/8/2019 was the depth to the surface of the recharged groundwater in the well.			

Groundwater levels were recorded at the time and under the conditions at which the borings were performed, and at the time and under the conditions at which the groundwater measurements in the observation well were taken. Fluctuations in groundwater levels due to changes in temperature, weather, and other conditions should be anticipated. As a result, groundwater levels encountered during construction and thereafter may differ from those reported herein.

Conclusions and Recommendations

The following geotechnical engineering conclusions and recommendations regarding the proposed slope are subject to the attached Statement of Limitations in Appendix A.

Conclusions

We evaluated stability of the proposed 3H:1V slope using the results of the test borings and laboratory testing. We performed a limit equilibrium slope stability analysis using the 2012 GeoStudio – Slope/W program. The program allows us to assess the potential stability of a constructed fill slope supported on the existing natural glacial till subgrade. The program input includes information about the existing ground conditions as assessed through the test boring and laboratory testing program, and proposed construction using compacted structural fill.

We performed the analysis based on saturated soil conditions since stormwater infiltration is planned at the proposed basins located at the top of slope.

The results of our slope stability analysis indicate an adequate factor of safety (1.3) against slope failure based on a saturated 3H:1V slope constructed with compacted lifts of suitable processed gravel fill placed over the natural glacial till soils. In our opinion the slope should be no steeper than 3H:1V.

In the following section we provide recommendations pertaining to gradation, placement and compaction of the processed gravel fill. Adequate placement and compaction of suitable structural fill with relatively high strength, such as processed gravel fill, is critical in creating a stable condition for the proposed slope.

Recommendations

The topsoil and subsoil materials, as well as tree stumps, should be stripped from the proposed slope area prior to the placement of compacted structural fill. Compacted lifts of structural fill should then be placed up to proposed subgrade elevations (proposed bottom of loam elevations).

Reuse of excavated on-site glacial till soils as compacted structural fill within this proposed slope area is not recommended. The on-site glacial till soils have a relatively high fines content (percent passing the no. 200 sieve) and are considered moisture sensitive and difficult to handle.

Off-site processed gravel fill is recommended for use as structural fill within the proposed slope area where a raise in grade is proposed. The off-site processed gravel fill should be a well-graded, 3 inch minus structural fill with no more than 50 percent passing the ¾ inch sieve by weight, and no more than 10 percent passing the no. 200 sieve by weight.

A 5-gallon bucket sized sample of the off-site processed gravel fill shall be provided to Northeast Geotechnical for laboratory gradation, modified Proctor compaction, and direct shear testing at least 2 weeks prior to use. The results of the laboratory testing will be reviewed to assess conformance with the recommended gradation criteria and to assess that the minimum required soil friction angle may be achieved with this fill material. The results of the modified Proctor compaction testing should be used during slope construction to assess that the recommended minimum compaction percentages are achieved.

Compacted structural fill should be placed in horizontal lifts that do not exceed a loose thickness of 12 inches. Each lift should be keyed into the existing slope by cutting a bench, at least 18 inches wide, into the existing slope during spreading of each lift.

Each lift of structural fill should be compacted with suitable vibratory compaction equipment to a firm and stable condition, and to at least 95 percent of the fill material's maximum dry density as determined by ASTM D-1557. Suitable compaction equipment includes reversible vibratory plate compactors, walk behind vibratory double drum compactors, or self-propelled vibratory single drum compactors.

Perched groundwater may be encountered during slope construction. Exposed natural glacial till soils that are observed to become unstable in the presence of groundwater should be excavated down to firm ground and the resulting excavation should be backfilled with compacted lifts of off-site processed gravel fill.

Infiltrating stormwater at the top of the slope increases the potential for saturated ground conditions and possible breakout along the proposed slope surface. Therefore, adequate erosion protection should be implemented. Based on correspondence with WDA, we understand that a landscaped slope surface is preferable as opposed to a rip-rap stone slope surface.

Installation of a "permanent" turf reinforcement mat (TRM) appears to be a feasible option for erosion control on a 3H:1V slope. The chosen TRM should be submitted to Northeast Geotechnical for review and comment. The TRM should be installed in accordance with the manufacturer's recommendations.

Even with the installation of erosion controls, periodic maintenance of the slope surface over time should be anticipated.

Earthwork Observation and Testing

Northeast Geotechnical, Inc. should be retained to provide earthwork observation and soils testing services during construction of the proposed slope. The purpose of our participation is to observe that the contractor performs earthwork in general compliance with the recommendations presented in this report, and to verify our design assumptions in the field.

The recommendations presented herein are only considered valid provided Northeast Geotechnical observes the construction of the fill slope to proposed subgrade elevations on a full-time basis. In addition, we can provide engineering input in a timely manner if subsurface conditions are found to vary from those anticipated prior to construction and warrant a design change or a change in earthwork procedures.

We have enjoyed working with you on this project and look forward to continuing our involvement during future design and construction phases. If you have any questions or require additional information, please contact us at 508-598-3510.

Sincerely,

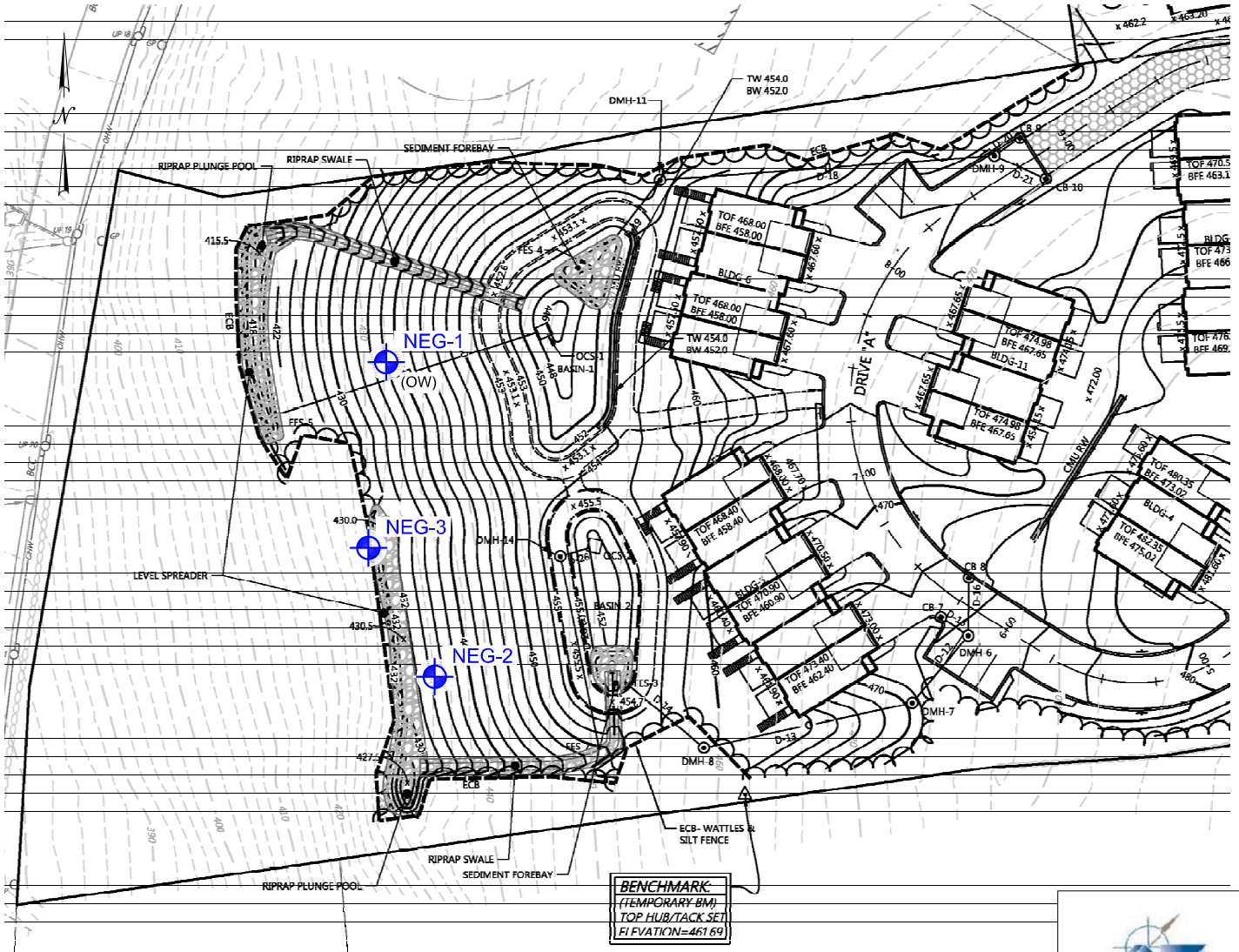
Northeast Geotechnical, Inc.

Mark M. Zambernardi, P.E.
Principal Engineer

James M. Handanyan, P.E.
Principal Engineer

Attachments: Figure No. 1 – Subsurface Exploration Location Plan
Appendix A – Limitations and Service Constraints
Appendix B – Test Boring Logs
Appendix C – Laboratory Soil Test Results

FIGURE



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NORTHEAST GEOTECHNICAL

NORTHEAST GEOTECHNICAL, INC.

BRIGATI VILLAGE

41 CHURCH STREET GRAFTON, MA

SUBSURFACE EXPLORATION LOCATION PLAN

Project No.: Z331.00	Drawn By: JJP	Reviewed By: M.ZAMBERNARDI, P.E.
Date: 5/12/2019	Scale: 1"=50'	Figure No.: 1

JACK POWERS, 05/13/2019, 17:20:57 | FILE: C:\NORTHEAST\2019\Z331.00 GRAFTON\PLANS\Z33100FO1.DWG

APPENDIX A

Limitations and Service Constraints

LIMITATIONS AND SERVICE CONSTRAINTS
Geotechnical Engineering Consulting Services

The opinions, conclusions and recommendations presented in this report are based upon the scope of services, information obtained through the performance of the services, and the schedule as agreed upon by Northeast Geotechnical, Inc. and the party for whom this report was originally prepared. This report is an instrument of professional service and was prepared in accordance with the generally accepted standards and level of skill and care under similar conditions and circumstances established by the geotechnical consulting industry. No representation, warranty, or guarantee, express or implied, is intended or given. To the extent that Northeast Geotechnical, Inc. relied upon any information prepared by other parties not under contract to Northeast Geotechnical, Inc. , Northeast Geotechnical, Inc. makes no representation as to the accuracy or completeness of such information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and/or other specifically named parties have the right to make use of and rely upon this report. Reuse of this report or any portion thereof for other than its intended purpose, or if modified, or if used by third parties, shall be at the user's sole risk.

Furthermore, nothing contained in this document shall relieve any other party of its responsibility to abide by contract documents and applicable laws, codes, regulations, or standards.

Subsurface Explorations and Testing

Results of any observations, subsurface exploration or testing, and any findings presented in this report apply solely to conditions existing at the time when Northeast Geotechnical, Inc.'s exploratory work was performed. It must be recognized that any such observations and exploratory or testing activities are inherently limited and do not represent a conclusive or complete characterization. Conditions in other parts of the project site may vary from those at the locations where data were collected and conditions can change with time. Northeast Geotechnical, Inc.'s ability to interpret exploratory and test results is related to the availability of the data and the extent of the exploratory and testing activities.

The findings, conclusions and recommendations submitted in this report are based, in part, on data obtained from subsurface borings, test pits, and specific, discrete sampling locations. The nature and extent of variation between these test locations, which may be widely spaced, may not become evident until construction. If variations are subsequently encountered, it will be necessary to re-evaluate the conclusions and recommendations of this report.

Correlations and descriptions of subsurface conditions presented in boring logs, test pit logs, subsurface profiles, and other materials are approximate only. Subsurface conditions may vary significantly from those encountered in borings and sampling locations and transitions between subsurface materials may be gradual or highly variable.

Conditions at the time water level measurements and other subsurface observations were made are presented in the boring logs or other sampling forms. These field data have been reviewed and interpretations provided in this report. However, groundwater levels may be variable and may fluctuate due to variation in precipitation, temperature, and other factors. Therefore, groundwater levels at the site at any time may be different than stated in this report.

Review

In the event that any change in the nature, design, or location of the proposed structure(s) is planned, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or verified in writing.

Northeast Geotechnical, Inc. should be provided the opportunity for a general review of final design plans and specifications to assess that our recommendations have been properly interpreted and included in the design and construction documents.

Construction

To verify conditions presented in this report and modify recommendations based on field conditions encountered in the field, Northeast Geotechnical, Inc. should be retained to provide geotechnical engineering services during the construction phase of the project. This is to observe compliance with design concepts, specifications, and recommendations contained in this report, and to verify and refine our recommendations as necessary in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX B

Test Boring Logs

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Brigati Village
41 Church Street
Grafton, MA

Test Boring No.: NEG-1
Page: 1 of 2
File No.: Z331.00
Reviewed By: M. Zambernardi, P.E.

Boring Co.: Seaboard Drilling, Inc.
Foreman: Doug
Boring Equipment: Tracked ATV Rig; Hollow Stem Augers; Auto Trip Hammer

Date: 1/3/2019
Northeast Geotechnical Observer: Jeremy Caird
Test Boring Location: See Boring Location Plan
Ground Surface Elevation: 432±

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1	0-1.5'	18"	2"	1/12"-1		Topsoil 1.5'±	V. loose, dark brown, SILT, some F. Sand, some Organics, trace F. Gravel
	S-1A	1.5-2'	6"	3"	1		Subsoil 2'±	Tan to brown SILT, some F/M Sand, little (+) F. Gravel, trace Organics
5'	S-2	5-7'	24"	12"	7-18-15-23			Dense, light brown to gray, F/C SAND and SILT, some F. Gravel
10'	S-3	10-12'	24"	13"	13-15-21-24	1		Dense, light brown to gray, F/M SAND and SILT, little F/C Gravel
15'	S-4	15-17'	24"	15"	11-24-25-28	2	Natural Glacial Till	Dense, light brown to gray, F/M SAND and SILT, little (+) F. Gravel
20'	S-5	20-22'	24"	6"	34-55-44-38	3		Very dense, light brown to gray, F/M SAND and SILT, some F. Gravel
25'	S-6	25-27'	24"	17"	34-28-31-27			Very dense, light brown to gray, F/C SAND, some (+) Silt, little (+) F. Gravel

Notes:

1. Wet cuttings observed at approximately 11± feet during augering, possibly indicative of perched groundwater.
2. Augers grinding on possible cobbles and/or boulders at about 18± feet.
3. Apparent cobble/boulder fragments observed in split spoon sample no. S-5.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse
Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Brigati Village
41 Church Street
Grafton, MA

Test Boring No.: NEG-1
Page: 2 of 2
File No.: Z331.00
Reviewed By: M. Zambernardi, P.E.

Boring Co.: Seaboard Drilling, Inc.
Foreman: Doug
Boring Equipment: Tracked ATV Rig
Hollow Stem Augers
Auto Trip Hammer

Date: 1/3/2019
Northeast Geotechnical Observer: Jeremy Caird
Test Boring Location: See Boring Location Plan
Ground Surface Elevation: 432±

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-7	30-32'	24"	9"	20-38-59-52	4	Natural Glacial Till	Damp, very dense, light brown to gray, F/C GRAVEL, some F/C Sand, little (+) Silt
35'	S-8	35-35.5'	6"	1"	17			Light brown to gray, F/C GRAVEL, some F/C Sand, some Silt
	S-8A	35.5-35.7'	2"	1"	50/2"	5,6 7,8	35.7'±	Light brown to gray, F/C GRAVEL, trace F/M Sand, trace Silt
40'								Bottom of Boring at 35.7± ft.
45'								
50'								
55'								

Notes:

4. Apparent cobble/boulder fragments observed in split spoon sample no. S-7.
5. Refusal to split spoon sampler at 35.7± feet.
6. Apparent cobble/boulder fragments observed in split spoon sample no. S-8A.
7. Boring terminated at 35.7± feet below ground surface.
8. A 2 inch diameter PVC groundwater observation well installed to 35± ft. below ground surface: screen from 25± to 35± ft.; sand backfill to 2± ft. above screen followed by bentonite chips, then soil cuttings up to ground surface; 3± foot stickup.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Brigati Village
41 Church Street
Grafton, MA

Test Boring No.: NEG-2
Page: 1 of 1
File No.: Z331.00
Reviewed By: M. Zambernardi, P.E.

Boring Co.: Seaboard Drilling, Inc.
Foreman: Doug
Boring Equipment: Tracked ATV Rig
Hollow Stem Augers
Auto Trip Hammer

Date: 1/2/2019
Northeast Geotechnical Observer: Mark Zambernardi / Jeremy Caird
Test Boring Location: See Boring Location Plan
Ground Surface Elevation: 434±

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1	0-1.5'	18"	4"	1-2-1		Topsoil 1.5'±	Very loose, dark brown, SILT, some F. Sand, some Roots/Organics
	S-1A	1.5-2'	6"	3"	4		Subsoil 2'±	Light brown, C GRAVEL, some F/M Sand, little Silt, trace Roots
	S-2	2-4'	24"	13"	12-9-10-14	1		Medium dense, light brown, F/M SAND, some Silt, little (+) F. Gravel
5'	S-3	5-7'	24"	13"	13-18-20-36	2		Damp, dense, light brown, F/M SAND, some (+) F/C Gravel, some Silt
	S-4	7-9'	24"	16"	10-14-18-20	3		Dense, light brown, F/C SAND, some Silt, some F/C Gravel
10'	S-5	10-12'	24"	21"	13-18-20-36			Dense, light brown, F/C SAND, some (+) Silt, little (+) F. Gravel
15'	S-6	15-17'	24"	17"	19-21-25-31		Natural Glacial Till	Dense, light brown, F/M SAND and SILT, little F. Gravel
20'	S-7	20-22'	24"	8"	78-37-21-21	4 5		Very dense, light brown, F/M SAND, some Silt, little F. Gravel
25'	S-8	25-27'	24"	22"	10-11-25-33			Dense, gray to light brown, F/M SAND, some (+) Silt, little F. Gravel
	S-9	30-30.3'	4"	1"	50/4"	5,6	Auger Refusal	Gray, F/C GRAVEL (rock fragments) Bottom of Boring at 30.3± feet

Notes:

1. Apparent coarse gravel fragment in tip of split spoon sampler at 2± feet.
2. Auger grinding on apparent boulder and/or cobbles at 5± feet.
3. Apparent perched groundwater at 8± feet.
4. Apparent coarse gravel fragment in tip of split spoon sampler at 20± feet.
5. Augers grinding on apparent boulder and/or cobbles at 23± and 29± feet.
6. Refusal to the split spoon sampler and augers at about 30.3± feet. Apparent rock fragments in sample no. S-9.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Brigati Village
41 Church Street
Grafton, MA

Test Boring No.: NEG-3
Page: 1 of 2
File No.: Z331.00
Reviewed By: M. Zambernardi, P.E.

Boring Co.: Seaboard Drilling, Inc.
Foreman: Doug
Boring Equipment: Tracked ATV Rig; Hollow Stem Augers; Auto Trip Hammer

Date: 1/2-1/3/2019
Northeast Geotechnical Observer: Jeremy Caird
Test Boring Location: See Boring Location Plan
Ground Surface Elevation: 428±

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1	0-2'	24"	8"	1-1-2-2		Topsoil	Very loose, dark brown, SILT, some F. Sand, some Roots/Organics
	S-2	2-2.5'	6"	1"	2	1	2'±	Dark brown, SILT and F/M SAND, trace Roots
	S-2A	2.5-4'	18"	4"	2-6-12		Subsoil	Loose, light gray to brown, F/M SAND, some (+) Silt, little F. Gravel
5'	S-3	4-6'	24"	9"	3-3-12-10		5'±	Wet, medium dense, light brown, F/M SAND, some (+) Silt, little F/C Gravel, trace Roots
	S-4	6-8'	24"	17"	13-10-12-25	2		Damp, light brown, medium dense, F/M SAND and SILT, little F. Gravel
10'	S-5	9-11'	24"	13"	7-16-22-18	3		Moist, dense, light brown, F/C SAND, some Silt, some F/C Gravel
15'	S-6	14-16'	24"	19"	20-25-20-17			Dense, light brown to gray, F/M SAND and SILT, some F/C Gravel
20'	S-7	19-21'	24"	21"	30-49-54-36	4	Natural Glacial Till	Very dense, light brown to gray, F/C SAND and SILT, some F. Gravel
25'	S-8	24-26'	24"	7"	11-26-42-23	5		Very dense, gray to light brown, F/C SAND, some Silt, some F/C Gravel
	S-9	29-30'	12"	6"	9-45			Damp, very dense, gray to light brown, SILT and F/C SAND, some F.Gravel

Notes:

1. Apparent cobble/boulder fragments observed in split spoon sample no. S-2.
2. Apparent perched groundwater at 8± feet.
3. Groundwater measurement through the augers taken on 1/3/19. Groundwater measured to be at about 10± feet below ground surface.
4. Wet cuttings observed at 17± feet.
5. Apparent cobble/boulder fragments observed in split spoon sample no. S-8.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Brigati Village
41 Church Street
Grafton, MA

Test Boring No.: NEG-3
Page: 2 of 2
File No.: Z331.00
Reviewed By: M. Zambernardi, P.E.

Boring Co.: Seaboard Drilling, Inc.
Foreman: Doug
Boring Equipment: Tracked ATV Rig
Hollow Stem Augers
Auto Trip Hammer

Date: 1/2-1/3/2019
Northeast Geotechnical Observer: Jeremy Caird
Test Boring Location: See Boring Location Plan
Ground Surface Elevation: 428±

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-9A	30-30.8'	9"	3"	81-50/3"	6	Natural Glacial Till	Very dense, beige to gray, F/C GRAVEL, some F/C Sand, little Silt (possible rock fragments)
35'	S-10	34-36'	24"	10"	8-14-36-52	7	36'±	Damp, dense, gray to brown, F/M SAND and SILT, some F. Gravel
								Bottom of Boring at 36± feet
40'								
45'								
50'								
55'								

Notes:

6. Refusal to the split spoon sampler on apparent cobble/boulder at 30.8± feet.
7. Boring terminated at 36± feet

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse
Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

APPENDIX C

Laboratory Soil Test Results

THIELSCH ENGINEERING
14 Rocsam Park Road
Braintree, MA 02184
Phone: (781)-848-5184
Fax: (401)-467-2398
http://www.thielsch.com
Let's Build a Solid Foundation

Client Information:
Northeast Geotechnical, Inc.
North Attleboro, MA
PM: Mark Zambernardi
Assigned By: Mark Zambernardi
Collected By: NEG

Project Information:
Brigati Village
41 Church Street, Grafton, MA
NEG Project Number: Z331.00
Summary Page: 1 of 1
Report Date: 5/2/2019

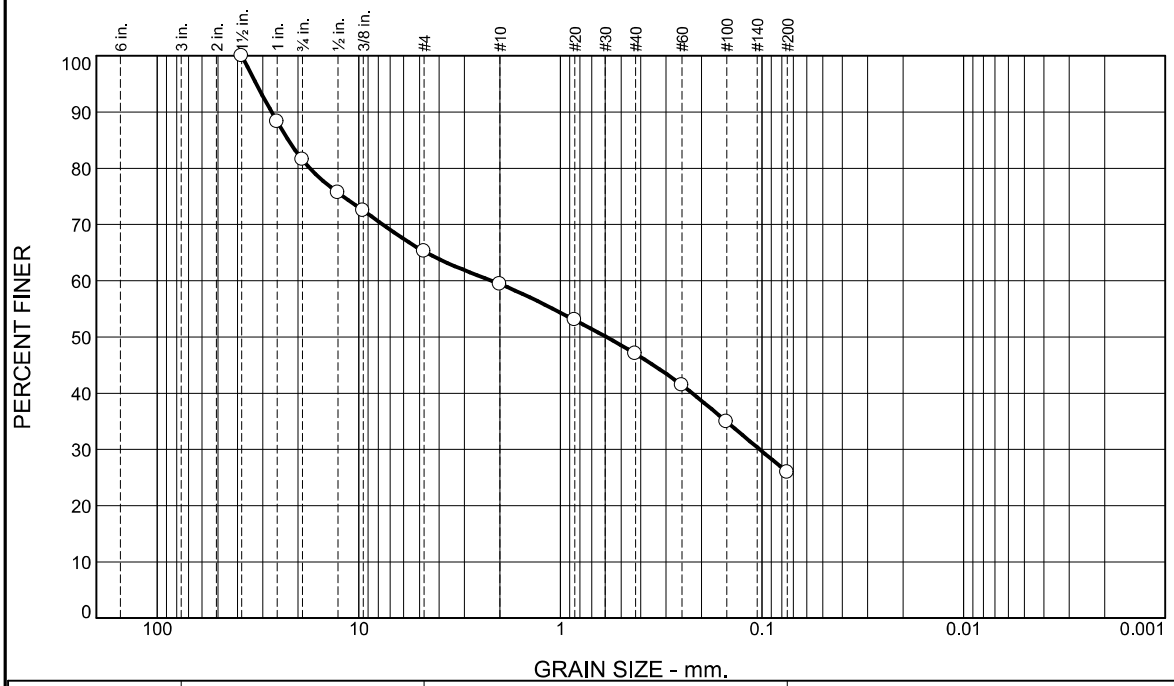
LABORATORY TESTING DATA SHEET

Boring ID	Sample No.	Depth (ft)	Laboratory No.	Identification Tests								Proctor / Direct Shear Tests							Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Strength (psf) @ 500 psf	Strength (psf) @ 1000 psf	Strength (psf) @ 1500 psf	EST. Shear Angle	
B-NEG-2	S-3	5-7	19-S-B089				34.8	39.3	25.9										Light brown silty sand with gravel (SM)
B-NEG-3	S-4	6-8	19-S-B090				16.7	46.5	36.8										Light brown silty sand with gravel (SM)
Composite	S-1		19-S-B091				18.8	38.6	42.6				137.0 / 6.7	139.5 / 5.8	560	1080	1480	42.7	Light brown silty sand with gravel (SM)

Reviewed By Ronelle LeBlanc

Date Reviewed 05.02.2019

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	18.4	16.4	5.8	12.4	21.1	25.9	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	88.3		
3/4"	81.6		
1/2"	75.7		
3/8"	72.5		
#4	65.2		
#10	59.4		
#20	53.0		
#40	47.0		
#60	41.4		
#100	34.9		
#200	25.9		

* (no specification provided)

Material Description

Light brown silty sand with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 27.0657 D_{85}= 22.3167 D_{60}= 2.1895
D_{50}= 0.5917 D_{30}= 0.1026 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/25/2019 **Date Tested:** 4/29/2019

Tested By: CC

Checked By: Ronelle LeBlanc, E.I.T.

Title: Laboratory Coordinator

Source of Sample: B-NEG-2 **Depth:** 5-7' **Date Sampled:** 4/25/2019
Sample Number: S-3

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical, Inc.
Project: Brigati Village
41 Church Street, Grafton, MA
Project No: Z331.00 **Figure** 19-S-B089

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.6	13.1	6.0	15.2	25.3	36.8	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	96.4		
1/2"	91.6		
3/8"	89.4		
#4	83.3		
#10	77.3		
#20	69.9		
#40	62.1		
#60	54.5		
#100	46.0		
#200	36.8		

* (no specification provided)

Material Description

Light brown silty sand with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 10.3577 D_{85}= 5.7712 D_{60}= 0.3627
D_{50}= 0.1913 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 4/25/2019 **Date Tested:** 4/29/2019

Tested By: CC

Checked By: Ronelle LeBlanc, E.I.T.

Title: Laboratory Coordinator

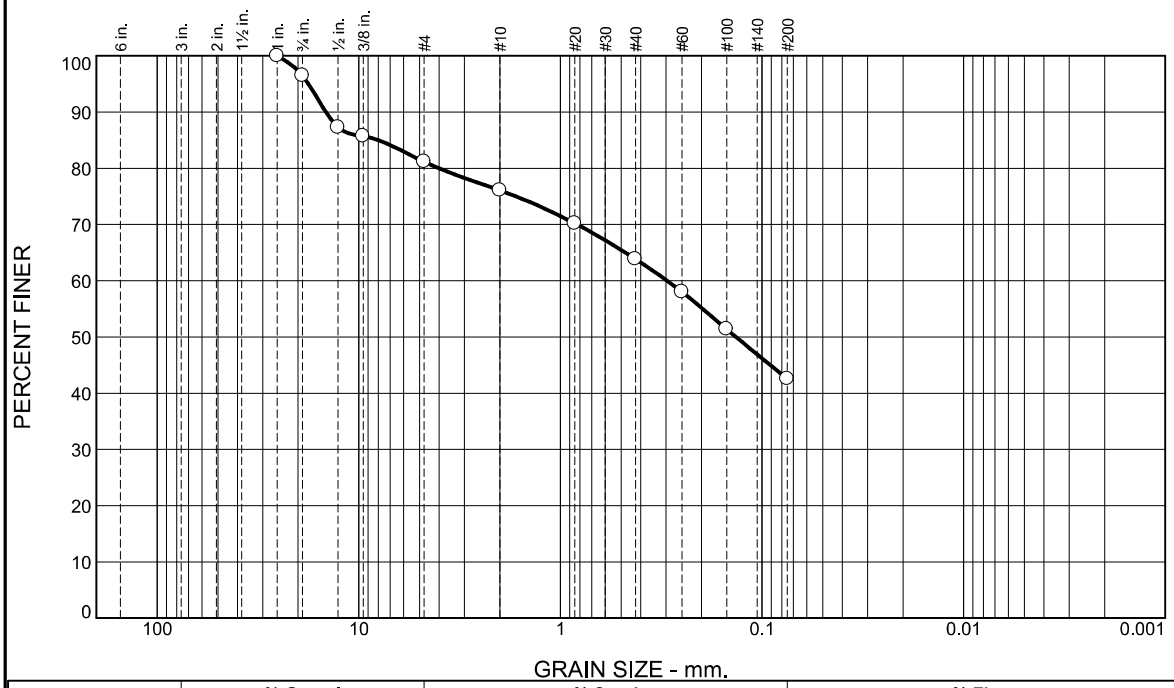
Source of Sample: B-NEG-3 **Depth:** 6-8' **Date Sampled:** 4/25/2019
Sample Number: S-4

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical, Inc.
Project: Brigati Village
41 Church Street, Grafton, MA
Project No: Z331.00 **Figure** 19-S-B090

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.5	15.3	5.1	12.2	21.3	42.6	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	96.5		
1/2"	87.3		
3/8"	85.7		
#4	81.2		
#10	76.1		
#20	70.2		
#40	63.9		
#60	58.0		
#100	51.4		
#200	42.6		

* (no specification provided)

Material Description

Light brown silty sand with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 14.5687 D_{85}= 7.9804 D_{60}= 0.2958
D_{50}= 0.1346 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 4/25/2019 **Date Tested:** 4/29/2019

Tested By: CC

Checked By: Ronelle LeBlanc, E.I.T.

Title: Laboratory Coordinator

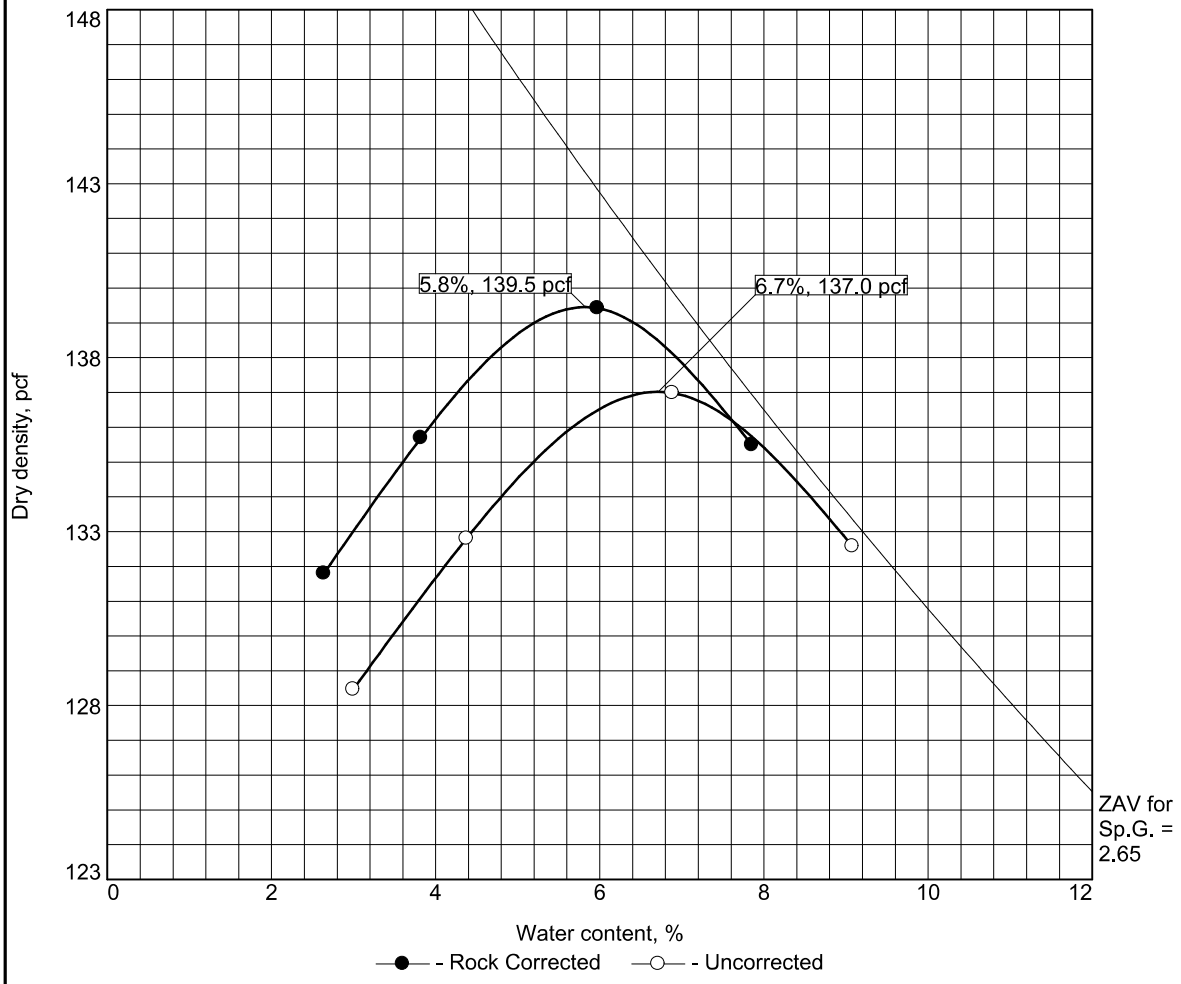
Source of Sample: Composite **Depth:** N/A **Date Sampled:** 4/25/2019
Sample Number: S-1

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical, Inc.
Project: Brigati Village
41 Church Street, Grafton, MA
Project No: Z331.00 **Figure** 19-S-B091

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
N/A	SM	A-4(0)		2.65	NV	NP	14.3	42.6

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 139.5 pcf	137.0 pcf	Light brown silty sand with gravel (SM)
Optimum moisture = 5.8 %	6.7 %	

Project No. Z331.00 **Client:** Northeast Geotechnical, Inc.
Project: Brigati Village
41 Church Street, Grafton, MA
○**Source of Sample:** Composite **Sample Number:** S-1

Thielsch Engineering Inc.

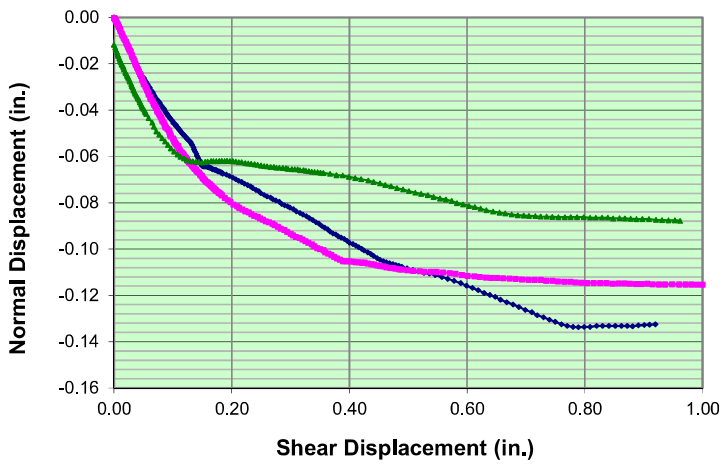
Cranston, RI

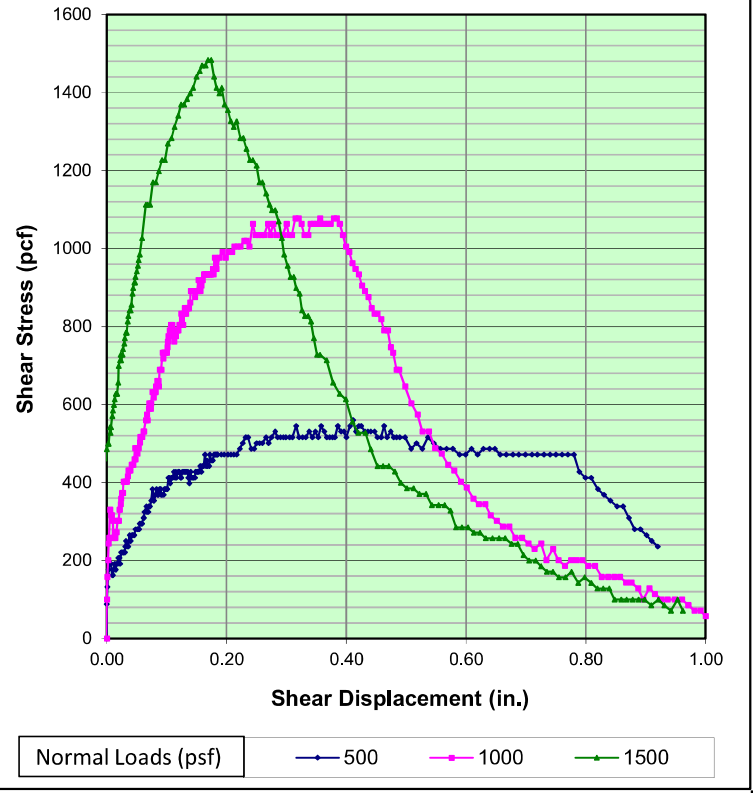
Remarks:

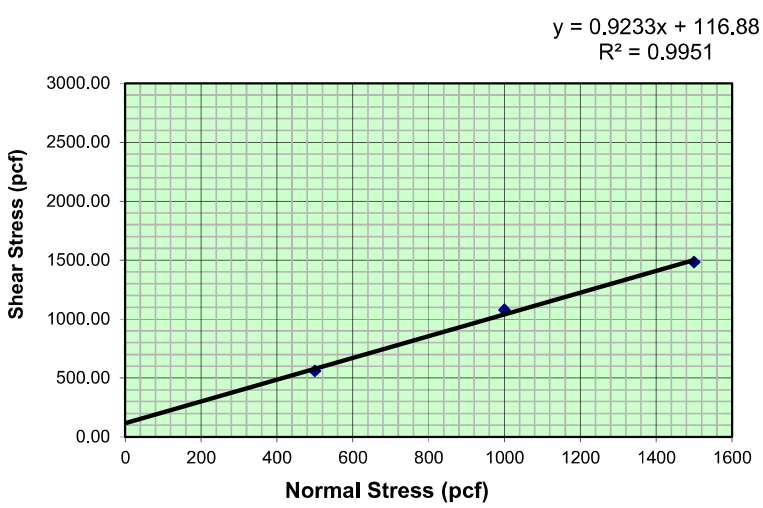
Figure 19-MC-

Tested By: RL/GP/CC **Checked By:** Ronelle LeBlanc, E.I.T.

Direct Shear Tests (ASTM D3080)







Project	Brigati Village	Project Manager	Mark Zambernardi
Location	41 Church Street, Grafton, MA	Assigned By	Mark Zambernardi
File No.	Z331.00	Tested By	JF
Test No.	19-DS-B091	Reviewed By	sa
Date	05.07.19	**Shear Angle (°)**	**42.7**
		Intercept (psf)	117

Boring _____ Sample No. **Composite S-1**

Sample **< 0.375" Material** Area (in^2) 6.2 2.8" Diameter Circle

THIELSCH ENGINEERING

195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454 Fax: (401)-467-2398
http://www.thielsch.com

Notes: Test sample material was compacted to 90% of maximum dry density (139.5 pcf) at 5.8% moisture content by tamping method per section 7.5.2 of ASTM D3080-11. Material was tested at saturated condition.

NORTHEAST GEOTECHNICAL, INC.
Delivering Practical Engineering Solutions

July 12, 2019 Project No. Z331.00

Mr. David W. Brossi
15 Juniper Lane
Grafton, MA 01519

SUBJECT: Geotechnical Engineering Report Addendum #1
Slope Stability Evaluation – Brigati Village
41 Church Street, 14 and 15 West Street
Grafton, MA

Dear David:

Northeast Geotechnical, Inc. is pleased to present this addendum #1 to our Geotechnical Engineering Report dated May 15, 2019 for the proposed slope located within the westerly portion of the subject site. This addendum summarizes the results of our additional geotechnical engineering studies pertaining to the proposed slope and associated stormwater basins.

This addendum is subject to the attached Limitations and Service Constraints.

Background

Northeast Geotechnical developed a Geotechnical Engineering Report, dated May 15, 2019 for the proposed project that at that time included stormwater infiltration basins located along the top of the proposed three horizontal to one vertical (3H:1V) slope located within the westerly portion of the subject site. Our previous studies included evaluation of slope stability based on saturated soil conditions resulting from the infiltration of collected stormwater in the basins at the top of the slope.

We have since been informed that stormwater infiltration is no longer planned in the noted basins, and we were provided with updated plans by WDA Design Group including the following, which we reviewed:

- "Grading and Drainage Plan, Sheet C3.02, dated 6/18/19" and
- "Details", Sheet C5.04, dated 6/18/19.

Based on our conference call with you and Mr. Wayne Belec of WDA Design Group on July 2, 2019, we performed additional geotechnical engineering studies that included evaluating stability of the westerly slope based on no stormwater infiltration in the noted basins at the top of the proposed slope, and evaluating stability of the proposed basin berms under full storage conditions (collected stormwater at top of berm elevation).

Geotechnical Engineering Stability Analysis and Conclusions

We evaluated stability of the proposed 3H:1V slope based on no stormwater infiltration in the proposed basins at the top of the proposed slope, and using the results of the test borings and laboratory testing as contained in our original geotechnical engineering report. We performed a limit equilibrium slope stability analysis using the 2016 GeoStudio– Slope/W program.

We performed the analysis based on the groundwater conditions encountered in the test borings at the time of drilling and based on the groundwater depth measurements taken in the observation well installed in test boring no. NEG-1.

The results of our slope stability analysis indicate an adequate factor of safety (1.7) against slope failure based on a 3H:1V slope constructed with compacted lifts of suitable processed gravel fill placed over the natural glacial till soils and the noted groundwater conditions.

We also evaluated the stability of the proposed stormwater basin berm under full storage conditions. The referenced "Details" plan specifies the earthen berms to be constructed of impervious soil borrow with sides graded to a 3H:1V slope having a crest width of no less than 10 feet. The noted section also specifies a minimum 3 foot wide keyway trench at the interface of the bottom of berm and underlying subgrade. The basin berms will be about 3.5 to 7 feet high. In our analysis, we assumed the berms will be constructed of on-site silty glacial till soils, or similar material, placed in controlled 12 inch thick lifts with each lift compacted to at least 95 percent of the fill material's maximum dry density as determined by ASTM D1557.

The results of our basin berm stability analysis indicate adequate factors of safety against sliding (5.6) and slope failure (1.7) under full storage conditions.

We also performed a pseudostatic stability analysis to assess the factor of safety against slope failure of the proposed 3H:1V slope subjected to the effects of earthquake forces. The design ground acceleration used in our analysis was based on the seismic parameters obtained from Table 1604.11 of the Massachusetts Building Code (ninth edition) for the Town of Grafton. The results of our pseudostatic stability analysis indicate an adequate factor of safety (1.3) against slope failure during the design seismic event.

We have enjoyed working with you on this project and look forward to continuing our involvement during future design and construction phases. If you have any questions or require additional information, please contact us at 508-598-3510.

Sincerely,

Northeast Geotechnical, Inc.

Mark M. Zambernardi, P.E.
Principal Geotechnical Engineer

James M. Handanyan, P.E.
Principal Geotechnical Engineer

Attachment: Limitations and Service Constraints
Grading and Drainage Plan, Sheet C3.02, dated 6/18/19, by WDA Design Group
Details, Sheet C5.04, dated 6/18/19, by WDA Design Group

APPENDIX A

Limitations and Service Constraints

LIMITATIONS AND SERVICE CONSTRAINTS
Geotechnical Engineering Consulting Services

The opinions, conclusions and recommendations presented in this report are based upon the scope of services, information obtained through the performance of the services, and the schedule as agreed upon by Northeast Geotechnical, Inc. and the party for whom this report was originally prepared. This report is an instrument of professional service and was prepared in accordance with the generally accepted standards and level of skill and care under similar conditions and circumstances established by the geotechnical consulting industry. No representation, warranty, or guarantee, express or implied, is intended or given. To the extent that Northeast Geotechnical, Inc. relied upon any information prepared by other parties not under contract to Northeast Geotechnical, Inc. , Northeast Geotechnical, Inc. makes no representation as to the accuracy or completeness of such information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and/or other specifically named parties have the right to make use of and rely upon this report. Reuse of this report or any portion thereof for other than its intended purpose, or if modified, or if used by third parties, shall be at the user's sole risk.

Furthermore, nothing contained in this document shall relieve any other party of its responsibility to abide by contract documents and applicable laws, codes, regulations, or standards.

Subsurface Explorations and Testing

Results of any observations, subsurface exploration or testing, and any findings presented in this report apply solely to conditions existing at the time when Northeast Geotechnical, Inc.'s exploratory work was performed. It must be recognized that any such observations and exploratory or testing activities are inherently limited and do not represent a conclusive or complete characterization. Conditions in other parts of the project site may vary from those at the locations where data were collected and conditions can change with time. Northeast Geotechnical, Inc.'s ability to interpret exploratory and test results is related to the availability of the data and the extent of the exploratory and testing activities.

The findings, conclusions and recommendations submitted in this report are based, in part, on data obtained from subsurface borings, test pits, and specific, discrete sampling locations. The nature and extent of variation between these test locations, which may be widely spaced, may not become evident until construction. If variations are subsequently encountered, it will be necessary to re-evaluate the conclusions and recommendations of this report.

Correlations and descriptions of subsurface conditions presented in boring logs, test pit logs, subsurface profiles, and other materials are approximate only. Subsurface conditions may vary significantly from those encountered in borings and sampling locations and transitions between subsurface materials may be gradual or highly variable.

Conditions at the time water level measurements and other subsurface observations were made are presented in the boring logs or other sampling forms. These field data have been reviewed and interpretations provided in this report. However, groundwater levels may be variable and may fluctuate due to variation in precipitation, temperature, and other factors. Therefore, groundwater levels at the site at any time may be different than stated in this report.

Review

In the event that any change in the nature, design, or location of the proposed structure(s) is planned, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or verified in writing.

Northeast Geotechnical, Inc. should be provided the opportunity for a general review of final design plans and specifications to assess that our recommendations have been properly interpreted and included in the design and construction documents.

Construction

To verify conditions presented in this report and modify recommendations based on field conditions encountered in the field, Northeast Geotechnical, Inc. should be retained to provide geotechnical engineering services during the construction phase of the project. This is to observe compliance with design concepts, specifications, and recommendations contained in this report, and to verify and refine our recommendations as necessary in the event that subsurface conditions differ from those anticipated prior to the start of construction.

REFERENCE PLANS

BASIS OF BEARINGS:
MASSACHUSETTS STATE PLANE
COORDINATE SYSTEM, MAINLAND ZONE

MATCH LINE

(SEE INSET)

CHURCH STREET
(PUBLIC - VARIABLE WIDTH)

WEST STREET
(PUBLIC - VARIABLE WIDTH)

DI-1
RIM=448.00
INV. (OUT)=441.50/ PIPE-DI-1

REMOVE & DISPOSE

ECB- WATTLES & SILT FENCE

CONTRACTOR TO EXECUTE EXTREME CARE WORKING IN THIS SENSITIVE AREA. SURFACE OF THIS AREA TO BE RESTORED TO CURRENT CONDITIONS. TEMPORARY ALTERATION AND RESORATION OF REPLICATION AREA= 125± S.F.

REPLICATION AREA

DMH-1W
RIM=446.24
INV. (IN)=439.48/ PIPE-DI-1
INV. (OUT)=439.48/ PIPE-1W

BENCHMARK:
TOP SPINDLE ON FIRE HYDRANT
ELEVATION=449.92

EXISTING DWELLING #13

EXISTING DWELLING #15

EXISTING GARAGE

EXISTING DWELLING #29 & #31

EXISTING DWELLING #33 & #35

ECB- WATTLES & SILT FENCE

TW 454.0
BW 452.0
BW 450.0

CMU BW

DMH-18

LANDSCAPING

100' BUFFER LAWN

25' NDZ

BBVW

WETLAND

LEVEL SPREADER

DB-4

TOF 458.00
BFE 457.67

CB-12

DMH-12 (STU)

CB-11

BLDG-1
TOF 461.00
BFE 453.67

TOF 464.00
BFE 456.67

DRIVE 'A'

RIPRAP PLUNGE POOL

RIPRAP EMERGENCY SPILLWAY

GRAVEL WETLAND
(2 TREATMENT CELLS)

ECB- WATTLES & SILT FENCE

INFILTRATION BASIN

INF-1A

INF-1B

TW 467.5
BW 464.0

TW 467.0
BW 463.5

TW 469.5
BW 466.0

1.5:1 RIPRAP SLOPE STABILIZATION

DMH-11

TW 454.0
BW 452.0

RIPRAP SWALE

SEDIMENT FOREBAY

RIPRAP PLUNGE POOL

DMH-9 (STU)

CB-10

CB-1

CB-2

DMH-10

BLDG-2
TOF 473.50
BFE 466.17

BLDG-3
TOF 475.00
BFE 467.67

TOF 470.50
BFE 463.17

TOF 476.50
BFE 469.17

TOF 477.50
BFE 470.17

BLDG-11
TOF 474.50
BFE 467.65

TOF 474.50
BFE 467.65

TW 474.0
BW 472.0

TW 475.0
BW 472.0

CB-3

DMH-3

DMH-4

CB-5

CB-4

CB-6

CB-7

DMH-6 (STU)

TW 476.0
BW 472.0

BLDG-4
TOF 482.35
BFE 475.02

TOF 480.35
BFE 473.02

TOF 482.35
BFE 475.02

BLDG-5
TOF 481.00
BFE 471.00

BLDG-7
TOF 481.00
BFE 471.00

TOF 481.00
BFE 471.00

BLDG-8
TOF 488.00
BFE 480.67

TOF 488.00
BFE 480.67

BLDG-9
TOF 482.40
BFE 472.40

TOF 482.40
BFE 472.40

BLDG-10
TOF 489.33
BFE 482.00

TOF 489.33
BFE 482.00

TOF 483.33
BFE 482.00

DMH-5

DMH-7

DMH-8

OCS-1

BASIN-1

OCS-2

BASIN-2

OCS-3

FES-1

FES-2

FES-3

ECB

LEVEL SPREADER

RIPRAP SWALE

SEDIMENT FOREBAY

RIPRAP PLUNGE POOL

ECB- WATTLES & SILT FENCE

BENCHMARK:
(TEMPORARY BM)
TOP HUB/TACK SET
ELEVATION=461.69

APPROXIMATE LOCATION OF CONDO UNITS (TYP.) #65-#68

#57-#63

NOTTINGHAM ROAD

BENCHMARK:
(TEMPORARY BM)
TOP SPIKE SET
ELEVATION=485.18

ECB- WATTLES & SILT FENCE

WETLAND

INSET
MATCH LINE

CHURCH STREET
(PUBLIC – VARIABLE

SIDELINE OF CHURCH

SIDELINE OF 1969 LAYOUT

DMH-3W

PIPE-2W

DMH-2W

ECB- SILT SACK (TYP)

APPROXIMATE LOCATION OF DRAIN PIPE AS SHOWN ON PLAN OF LAND PREPARED BY BLACKSTONE VALLEY AND MAPPING DATED. TO BE FIELD VERIFIED BY SITE CONTRACTOR.

SEE SHEET GN1.00 FOR GENERAL NOTES AND LEGEND.

H:\PROJECTS\1046\CAD\DWG\1046300.dwg

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNTIL ISSUED AS A CONSTRUCTION DRAWING BY WDA DESIGN GROUP.

CONDITIONALLY APPROVED
GRAFTON PLANNING BOARD

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

REV.	DATE	DESCRIPTION	INIT.
C	6/18/19	PEER REVIEW & TOWN COMMENTS	
B	5/17/19	PEER REVIEW & TOWN COMMENTS	
A		INITIAL ISSUE	

COMMONWEALTH OF MASSACHUSETTS
MICHAEL J. SCOTT
CIVIL
No. 40863
REGISTERED PROFESSIONAL ENGINEER

PREPARED BY:

WDA DESIGN GROUP
31 EAST MAIN STREET WESTBOROUGH, MA | 508.366.6552
WDA-DG.COM

OWNERS:
DAVID W. BROSSI
15 Juniper Lane
Grafton, MA 01519
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

PREPARED FOR:
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

TITLE:
GRADING AND DRAINAGE PLAN

"BRIGATI VILLAGE"
41 CHURCH STREET/
14 WEST STREET
Grafton, MA
(Worcester County)

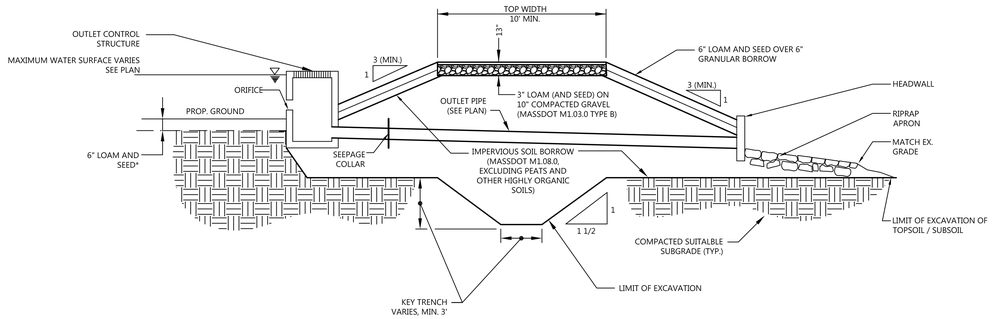
LOCAL PERMITTING

SCALE: 1" = 40'
0 40 80 120

JOB NO.:	1046.05	DATE:	02/07/19
DWN. BY:	JTA	SHEET:	C3.02
CHK'D. BY:	WMB		

NOTES:
1. REMOVE TOP/SUBSOIL. SEED MIX TO BE MOISTURE TOLERANT GRASSES.

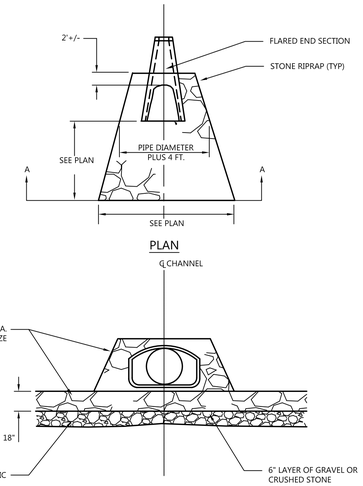
2. AFTER THE BASIN FLOOR IS SHAPED, PLACE SOIL ADDITIVES ON THE BASIN FLOOR TO AMEND THE SOIL. THE SOIL ADDITIVES SHALL INCLUDE COMPOST, PROPERLY AGED TO KILL ANY SEED STOCK CONTAINED WITHIN THE COMPOST. DO NOT PUT BIOSOLIDS IN THE COMPOST. MIX NATIVE SOILS THAT WERE EXCAVATED FROM THE A OR B HORIZONS TO CREATE THE BASIN WITH THE COMPOST, AND THEN SCARIFY THE NATIVE MATERIALS AND COMPOST INTO THE PARENT MATERIAL USING A CHISEL PLOW OR ROTARY DEVICE TO A DEPTH OF 12 INCHES. IMMEDIATELY AFTER CONSTRUCTING THE BASIN, STABILIZE ITS BOTTOM AND SIDE SLOPES WITH A DENSE TURF OF WATER-TOLERANT GRASS. USE LOW-MAINTENANCE, RAPIDLY GERMINATING GRASSES, SUCH AS FESCUES. THE SELECTED GRASSES MUST BE CAPABLE OF SURVIVING IN BOTH WET AND DRY CONDITIONS. DO NOT USE SOD, WHICH CAN PREVENT ROOTS FROM DIRECTLY CONTACTING THE UNDERLYING SOIL. DURING THE FIRST TWO MONTHS, INSPECT THE NEWLY ESTABLISHED VEGETATION SEVERAL TIMES TO DETERMINE IF ANY REMEDIAL ACTIONS (E.G., RESEEDING, IRRIGATING) ARE NECESSARY.



DETENTION BASIN BERM SECTION

N.T.S. 02600-27

WDA, INC.



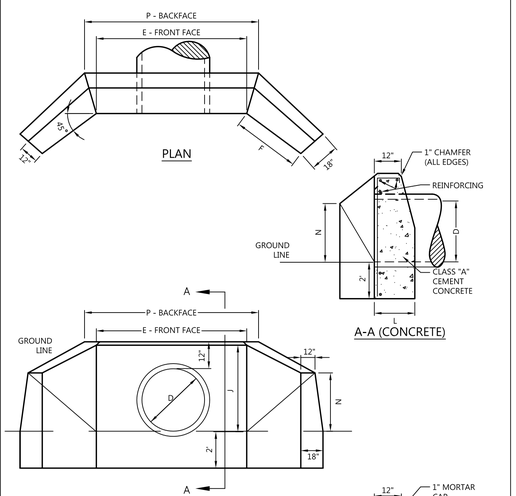
PLAN

SECTION A-A

RIPRAP APRON

N.T.S. 02600-15

WDA, INC.



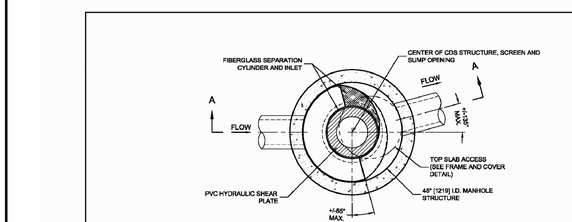
PIPE DIAM.	2 : 1 SLOPE					
D	E	P	J	N	L	F
< 30"	4'	5'-3"	3'-6"	2'	1'-6"	4'-3"
36"	4'-6"	5'-11"	4'	2'-3"	1'-8"	5'
48"	5'-6"	7'-2"	5'	2'-9"	2'	6'-6"
60"	6'-6"	8'-5"	6'	3'-3"	2'-4"	8'
72"	7'-6"	9'-9"	7'	3'-9"	2'-8"	9'-6"
84"	8'-6"	11'	8'	4'-3"	3'	11'

NOTES:
1. FOR DESCRIPTIONS, MATERIALS, AND CONSTRUCTION METHODS, SEE LATEST MHDSS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. ALL REINFORCING TO BE #3 BARS AT 12" EACH WAY (TYP.) WITH 1-1/2" CLEARANCE (MIN.).

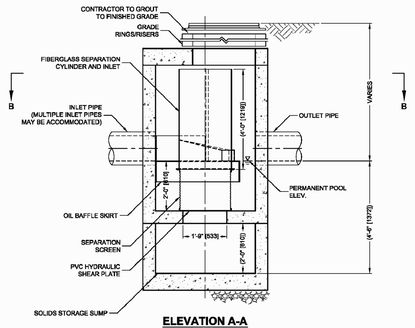
HEADWALL WITH WINGWALLS (WW)

N.T.S. 02600-41

WDA, INC.

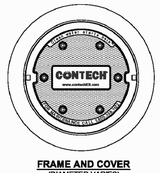


PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.

CDS2015-4-C DESIGN NOTES
THE STANDARD CDS2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.
CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS			
STRUCTURE ID			*
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST	WIDTH		HEIGHT
	*		*
NOTES/SPECIAL REQUIREMENTS:			
* PER ENGINEER OF RECORD			

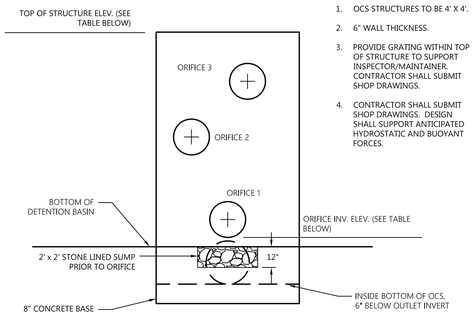
GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET H20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS2015-4-C
INLINE CDS
STANDARD DETAIL

ISOMETRIC VIEW



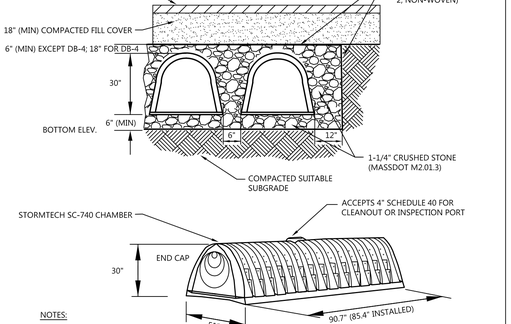
NOTES:
1. OCS STRUCTURES TO BE 4' X 4'.
2. 6" WALL THICKNESS.
3. PROVIDE GRATING WITHIN TOP OF STRUCTURE TO SUPPORT INSPECTOR/MAINTAINER. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS.
4. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS. DESIGN SHALL SUPPORT ANTICIPATED HYDROSTATIC AND BUOYANT FORCES.

OCS #	ORIFICE 1 SIZE (INCHES)	ORIFICE 1 ELEV.	ORIFICE 2 SIZE (INCHES)	ORIFICE 2 ELEV.	ORIFICE 3 SIZE (INCHES)	ORIFICE 3 ELEV.	OUTLET SIZE (INCHES)	OUTLET INVERT ELEV.	TOP OF STRUCTURE ELEV.
1	4"	446.75	6"	451.50	N/A	N/A	18"	446.0	451.95
2	4"	452.85	3 x 10"	453.95	N/A	N/A	18"	449.90	454.40
3	4"	465.30	6"	467.00	6"	468.80	18"	464.0	469.50

OUTLET CONTROL STRUCTURE (OCS)

N.T.S. 02600-14

WDA, INC.



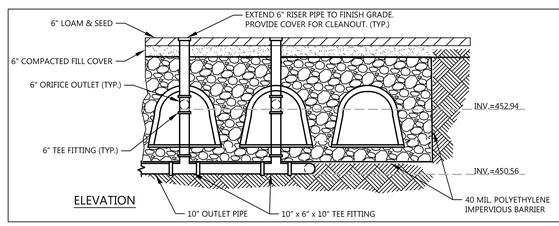
NOTES:
1. REQUIRES H-20 LOADING.
2. "STORMTECH SC-740" BY INFILTRATOR SYSTEMS, OR EQUAL AS APPROVED BY THE ENGINEER.
3. INSTALLATION IS TO BE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
4. PROVIDE CLEANOUTS/INSPECTION PORTS ON ALTERNATING ROWS AT 50' INTERVALS.

SYSTEM DESIGNATION	BOTTOM ELEV.	INVERT ELEV.	# OF ROWS	WIDTH OF STONE	# OF UNITS/ROW	LENGTH OF STONE	TOTAL # OF UNITS
DB-4	450.90	452.94	3	16.75'	11	83'	33
INF-1 (A)	474.50	476.54	2	12.5'	2	18'	4
INF-1 (B)	472.00	474.04	2	12.5'	2	18'	4

STORMWATER INFILTRATION SYSTEM (INF)

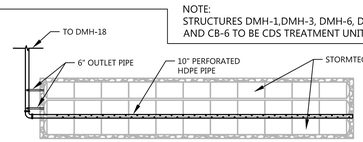
N.T.S. 02600-12-STORMTECH

WDA, INC.



ELEVATION

NOTE:
STRUCTURES DMH-1,DMH-3, DMH-6, DMH-9,DMH-12, AND CB-6 TO BE CDS TREATMENT UNITS.



PLAN

DB-4 OCS CONFIGURATION

N.T.S.

WDA, INC.

CONDITIONALLY APPROVED
GRAFTON PLANNING BOARD

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

SIGNATURE DATE

REV.	DATE	DESCRIPTION	INIT.
C	6/18/19	PEER REVIEW & TOWN COMMENTS	
B	5/17/19	PEER REVIEW & TOWN COMMENTS	
A		INITIAL ISSUE	

COMMONWEALTH OF MASSACHUSETTS
MICHAEL J. SCOTT
CIVIL
No. 40853
REGISTERED PROFESSIONAL ENGINEER

PREPARED BY:

WDA DESIGN GROUP
31 EAST MAIN STREET WESTBOROUGH, MA | 508.366.6552
WDA-DG.COM

OWNERS:
DAVID W. BROSSI
15 Juniper Lane
Grafton, MA 01519
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

PREPARED FOR:
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

TITLE:
DETAILS

"BRIGATI VILLAGE"
41 CHURCH STREET/
14 WEST STREET
Grafton, MA
(Worcester County)

LOCAL PERMITTING

JOB NO.:	1046.05	DATE:	02/07/19
DWN. BY:	CMP	SHEET:	C5.04
CHK'D. BY:	WMB		

H:\PROJECTS\1046\CAD\DWG\1046500.dwg

APPENDIX D

STABILITY ANALYSES
COMPUTATIONAL OUTPUT

SLOPE/W Analysis

File Information

File Version: 8.16
Revision Number: 17
Date: 7/12/2019
Time: 3:42:38 PM
Tool Version: 8.16.5.15361
File Name: May 15 Report (Sat Cond) Grafton MA (5-8-2019).gsz
Directory: C:\Users\Mark Zambernardi.DESKTOP-2REL423\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\BYVJRFW3\
Last Solved Date: 7/12/2019
Last Solved Time: 3:42:38 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001
- Minimum Slip Surface Depth: 0.1 ft
- Search Method: Root Finder
- Tolerable difference between starting and converged F of S: 3
- Maximum iterations to calculate converged lambda: 20
- Max Absolute Lambda: 2

Materials

Natural Glacial Till

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 42 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Compacted Structural Fill

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Point
Left Coordinate: (0, 153) ft
Left-Zone Increment: 4
Right Projection: Point
Right Coordinate: (196.67046, 90.11218) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 153) ft
Right Coordinate: (225, 90) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)

Coordinate 1	0	153
Coordinate 2	103	122
Coordinate 3	197	90
Coordinate 4	225	90

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	141
Point 3	103	122
Point 4	197	90
Point 5	225	90
Point 6	225	0
Point 7	0	153

Regions

	Material	Points	Area (ft²)
Region 1	Natural Glacial Till	1,2,3,4,5,6	26,029
Region 2	Compacted Structural Fill	2,7,3	618

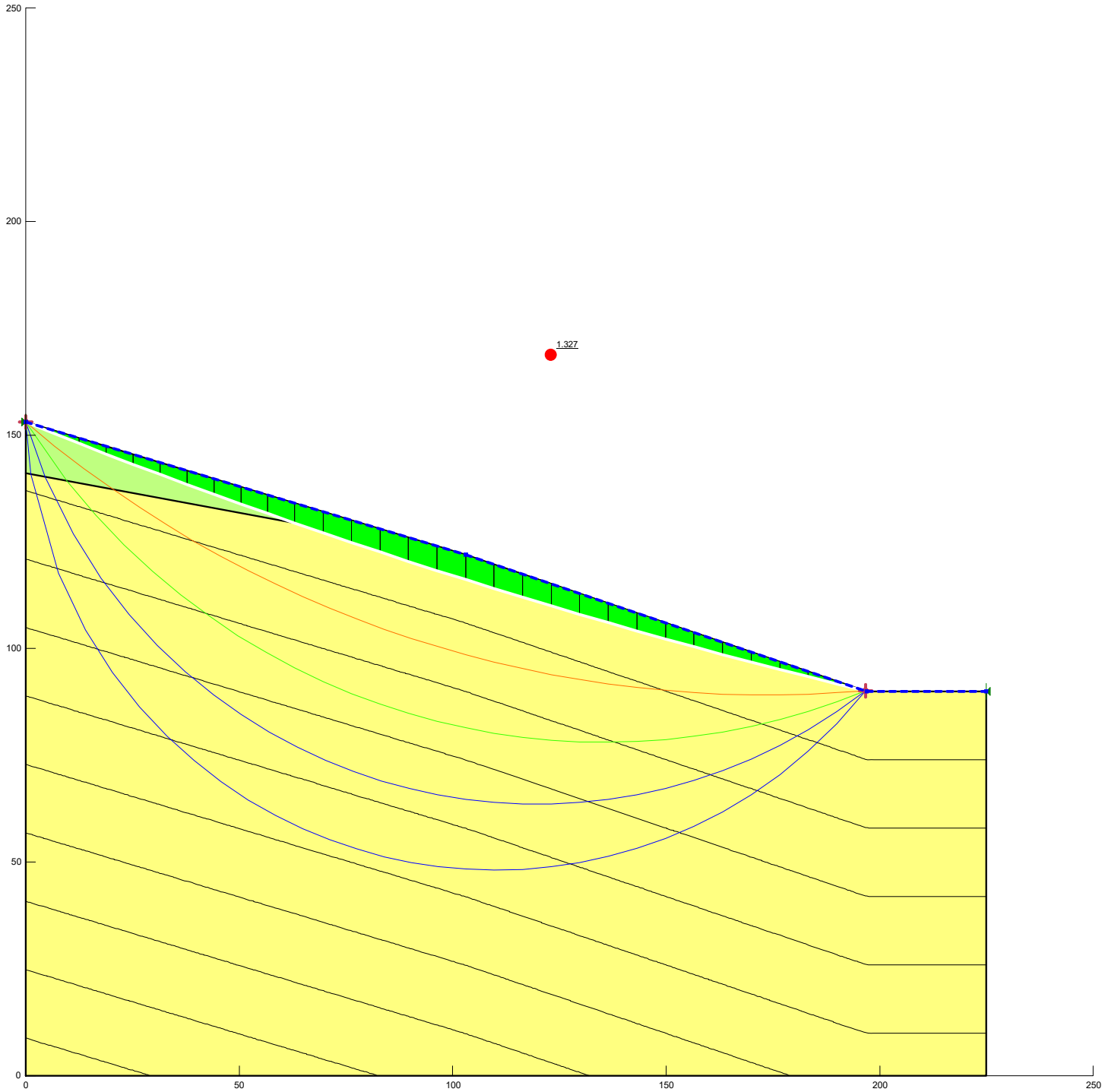
Current Slip Surface

Slip Surface: 1
F of S: 1.327
Volume: 708.68994 ft³
Weight: 94,255.762 lbs
Resisting Moment: 53,788,493 lbs-ft
Activating Moment: 40,531,035 lbs-ft
Resisting Force: 36,203.305 lbs
Activating Force: 27,278.086 lbs
F of S Rank (Analysis): 1 of 5 slip surfaces
F of S Rank (Query): 1 of 5 slip surfaces
Exit: (196.67046, 90.112183) ft
Entry: (0, 153) ft
Radius: 1,415.9058 ft
Center: (528.43038, 1,466.6022) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	3.150329	151.74146	19.36789	36.966307	13.74939	0
Slice 2	9.4509869	149.24184	57.014455	108.43266	40.172301	0
Slice 3	15.751645	146.77702	92.488728	175.26139	64.669095	0
Slice 4	22.052303	144.34683	125.80286	237.64055	87.377178	0
Slice 5	28.352961	141.95106	156.96874	295.7633	108.4382	0

Slice 6	34.653619	139.58953	185.99799	349.82164	127.99307	0
Slice 7	40.954276	137.26206	212.90202	400.00008	146.17702	0
Slice 8	47.254934	134.96848	237.69196	446.46933	163.11476	0
Slice 9	53.555592	132.70859	260.37872	489.38046	178.91577	0
Slice 10	59.85625	130.48224	280.97297	528.85936	193.67007	0
Slice 11	66.339364	128.22674	299.95946	566.18891	239.71408	0
Slice 12	73.004934	125.9439	317.22555	601.65298	256.09961	0
Slice 13	79.670505	123.69802	332.18501	633.2864	271.11291	0
Slice 14	86.336075	121.48892	344.84938	661.00313	284.66612	0
Slice 15	93.001645	119.31643	355.22996	684.68071	296.63879	0
Slice 16	99.667215	117.18035	363.33777	704.16761	306.88457	0
Slice 17	106.34537	115.07663	360.95415	703.29933	308.24899	0
Slice 18	113.03612	113.00522	348.08117	681.71687	300.40693	0
Slice 19	119.72687	110.97001	332.95009	655.19776	290.1531	0
Slice 20	126.41762	108.97082	315.57109	623.63532	277.38228	0
Slice 21	133.10836	107.00749	295.95409	586.96733	262.0295	0
Slice 22	139.79911	105.07988	274.10875	545.18183	244.07529	0
Slice 23	146.48986	103.18782	250.04453	498.31907	223.5474	0
Slice 24	153.1806	101.33117	223.77066	446.46938	200.51883	0
Slice 25	159.87135	99.509794	195.29615	389.76715	175.10248	0
Slice 26	166.5621	97.723541	164.62977	328.3818	147.44299	0
Slice 27	173.25285	95.972277	131.78009	262.50653	117.70661	0
Slice 28	179.94359	94.255868	96.755478	192.3461	86.070181	0
Slice 29	186.63434	92.574183	59.564082	118.10462	52.71014	0
Slice 30	193.32509	90.927094	20.213847	39.974412	17.792492	0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SLOPE/W Analysis

File Information

File Version: 8.16
Revision Number: 30
Date: 7/12/2019
Time: 3:51:39 PM
Tool Version: 8.16.5.15361
File Name: July 12 Addendum - Grafton MA (7-12-2019).gsz
Directory: C:\Users\Mark Zambernardi.DESKTOP-2REL423\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\BYVJRFW3\
Last Solved Date: 7/12/2019
Last Solved Time: 3:51:40 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001
- Minimum Slip Surface Depth: 0.1 ft
- Search Method: Root Finder
- Tolerable difference between starting and converged F of S: 3
- Maximum iterations to calculate converged lambda: 20
- Max Absolute Lambda: 2

Materials

Natural Glacial Till

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 42 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Compacted Structural Fill

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Point
Left Coordinate: (0, 153) ft
Left-Zone Increment: 4
Right Projection: Point
Right Coordinate: (196.67046, 90.11218) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 153) ft
Right Coordinate: (225, 90) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)

Coordinate 1	0	141
Coordinate 2	103	122
Coordinate 3	197	90
Coordinate 4	225	90

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	141
Point 3	103	122
Point 4	197	90
Point 5	225	90
Point 6	225	0
Point 7	0	153

Regions

	Material	Points	Area (ft²)
Region 1	Natural Glacial Till	1,2,3,4,5,6	26,029
Region 2	Compacted Structural Fill	2,7,3	618

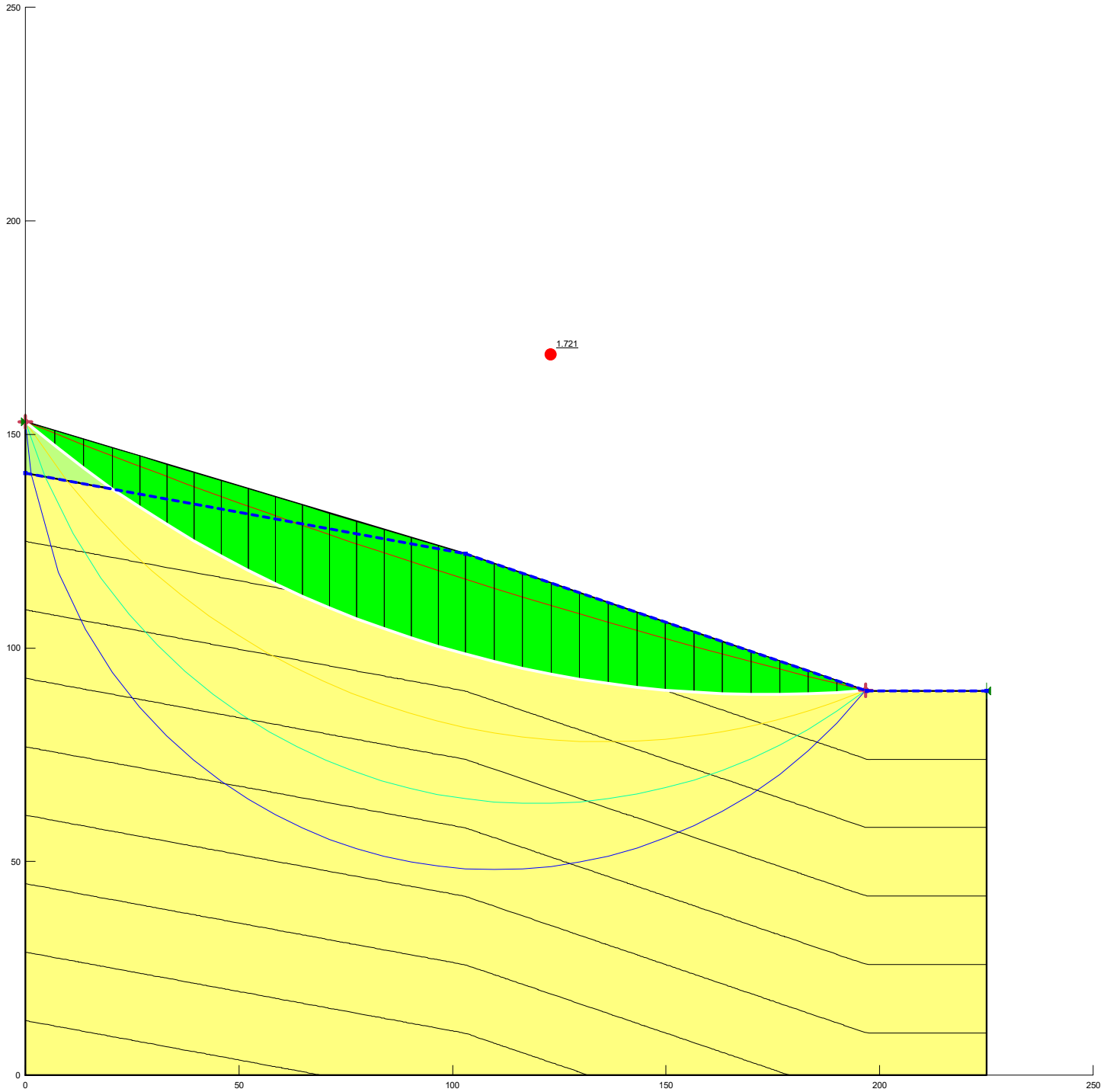
Current Slip Surface

Slip Surface: 2
F of S: 1.721
Volume: 3,063.2329 ft³
Weight: 407,409.98 lbs
Resisting Moment: 54,269,224 lbs-ft
Activating Moment: 31,539,489 lbs-ft
Resisting Force: 190,163.57 lbs
Activating Force: 110,527.23 lbs
F of S Rank (Analysis): 1 of 5 slip surfaces
F of S Rank (Query): 1 of 5 slip surfaces
Exit: (196.67046, 90.112183) ft
Entry: (0, 153) ft
Radius: 267.4592 ft
Center: (173.48201, 356.56428) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	3.4030936	150.19534	-612.96121	170.62173	133.3043	0
Slice 2	10.209281	144.76726	-352.59298	498.03397	389.10679	0
Slice 3	17.015468	139.68866	-114.03177	796.98474	622.67272	0
Slice 4	23.594771	135.08396	97.568835	1,054.3635	861.50178	0
Slice 5	29.947189	130.91409	284.64836	1,321.2873	933.3939	0

Slice 6	36.299607	126.99572	456.03362	1,560.3531	994.33371	0
Slice 7	42.652026	123.31618	612.51665	1,774.9688	1,046.6766	0
Slice 8	49.004444	119.8643	754.7933	1,967.9449	1,092.3266	0
Slice 9	55.356862	116.63025	883.47743	2,141.518	1,132.7449	0
Slice 10	61.709281	113.60532	999.11242	2,297.3656	1,168.9524	0
Slice 11	68.061699	110.78178	1,102.1806	2,436.6151	1,201.5302	0
Slice 12	74.414117	108.15276	1,193.1108	2,559.8526	1,230.6198	0
Slice 13	80.766536	105.71214	1,272.285	2,667.1336	1,255.9273	0
Slice 14	87.118954	103.45445	1,340.0437	2,758.004	1,276.7372	0
Slice 15	93.471372	101.37486	1,396.6899	2,831.5329	1,291.9384	0
Slice 16	99.823791	99.469017	1,442.4937	2,886.3686	1,300.0708	0
Slice 17	106.34537	97.691432	1,445.7904	2,905.6378	1,314.4525	0
Slice 18	113.03612	96.047631	1,406.235	2,885.9474	1,332.339	0
Slice 19	119.72687	94.584995	1,355.3749	2,838.4469	1,335.364	0
Slice 20	126.41762	93.300501	1,293.3988	2,760.3899	1,320.8847	0
Slice 21	133.10836	92.191551	1,220.4687	2,649.4292	1,286.6418	0
Slice 22	139.79911	91.255942	1,136.7222	2,503.8605	1,230.9768	0
Slice 23	146.48986	90.491845	1,042.2733	2,322.8284	1,153.017	0
Slice 24	153.1806	89.897783	937.21417	2,106.4692	1,052.8019	0
Slice 25	159.87135	89.472623	821.61563	1,855.9619	931.32963	0
Slice 26	166.5621	89.215557	695.52799	1,573.4785	790.51016	0
Slice 27	173.25285	89.1261	558.98152	1,262.0291	633.02688	0
Slice 28	179.94359	89.204085	411.98673	925.22291	462.11993	0
Slice 29	186.63434	89.449658	254.53445	566.96948	281.31777	0
Slice 30	193.32509	89.863281	86.595783	191.15999	94.150036	0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SLOPE/W Analysis

File Information

File Version: 8.16
Revision Number: 29
Date: 7/12/2019
Time: 2:06:40 PM
Tool Version: 8.16.5.15361
File Name: July 12 Addendum (seismic) - Grafton MA (7-12-2019).gsz
Directory: C:\Users\Mark Zambernardi.DESKTOP-2REL423\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\BYVJRFW3\
Last Solved Date: 7/12/2019
Last Solved Time: 3:50:24 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001
- Minimum Slip Surface Depth: 0.1 ft
- Search Method: Root Finder
- Tolerable difference between starting and converged F of S: 3
- Maximum iterations to calculate converged lambda: 20
- Max Absolute Lambda: 2

Materials

Natural Glacial Till

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 42 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Compacted Structural Fill

Model: Mohr-Coulomb
Unit Weight: 133 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Point
Left Coordinate: (0, 153) ft
Left-Zone Increment: 4
Right Projection: Point
Right Coordinate: (196.67046, 90.11218) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 153) ft
Right Coordinate: (225, 90) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)

Coordinate 1	0	141
Coordinate 2	103	122
Coordinate 3	197	90
Coordinate 4	225	90

Seismic Coefficients

Horz Seismic Coef.: 0.14
Vert Seismic Coef.: 0.14

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	141
Point 3	103	122
Point 4	197	90
Point 5	225	90
Point 6	225	0
Point 7	0	153

Regions

	Material	Points	Area (ft²)
Region 1	Natural Glacial Till	1,2,3,4,5,6	26,029
Region 2	Compacted Structural Fill	2,7,3	618

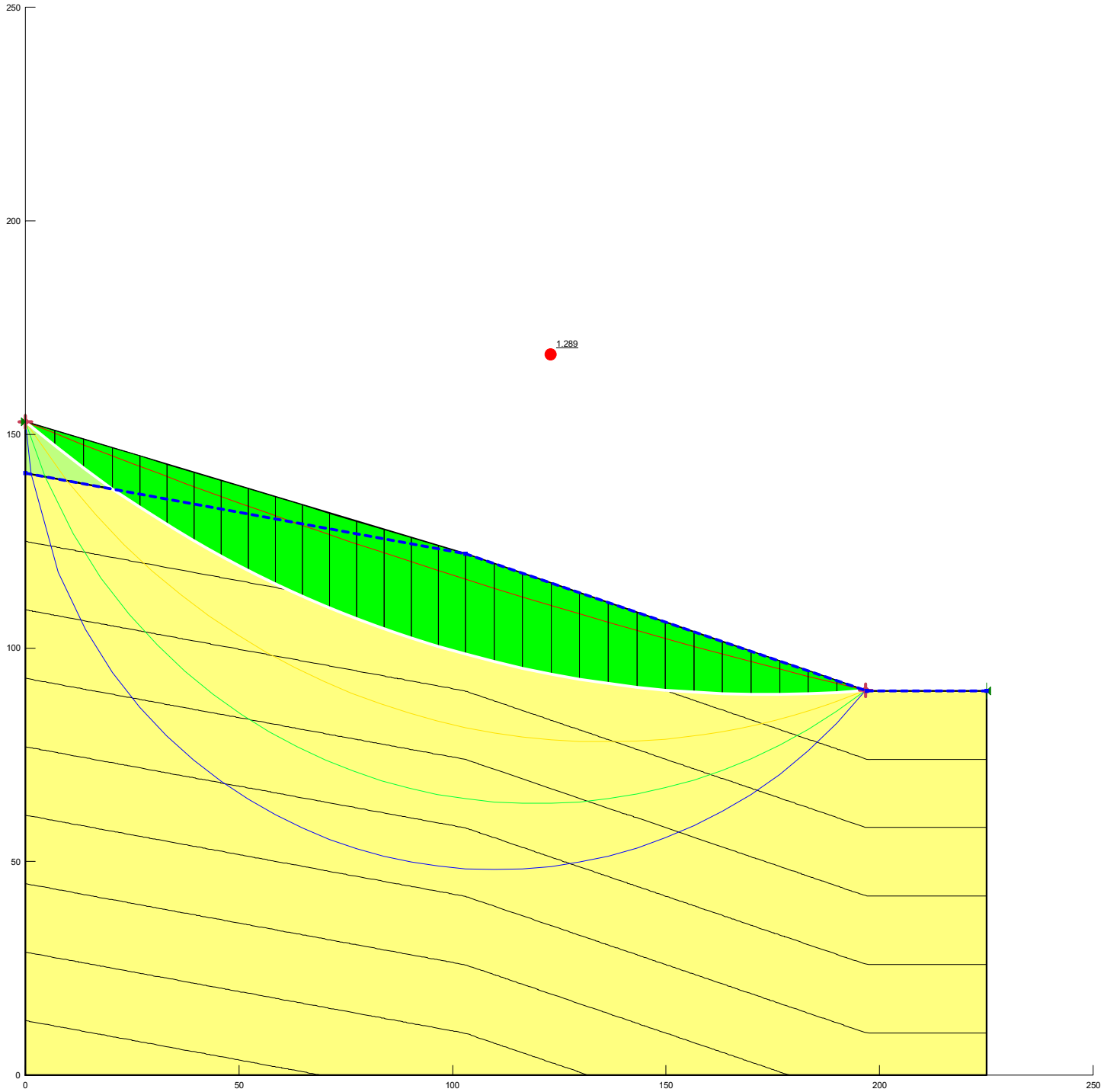
Current Slip Surface

Slip Surface: 2
F of S: 1.289
Volume: 3,063.2329 ft³
Weight: 407,409.98 lbs
Resisting Moment: 64,155,335 lbs-ft
Activating Moment: 49,782,105 lbs-ft
Resisting Force: 226,046.23 lbs
Activating Force: 175,376.18 lbs
F of S Rank (Analysis): 1 of 5 slip surfaces
F of S Rank (Query): 1 of 5 slip surfaces
Exit: (196.67046, 90.112183) ft
Entry: (0, 153) ft
Radius: 267.4592 ft
Center: (173.48201, 356.56428) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	3.4030936	150.19534	-612.96121	177.35539	138.56522	0
Slice 2	10.209281	144.76726	-352.59298	516.79967	403.76816	0
Slice	17.015468	139.68866	-114.03177	826.02969	645.36512	0

3						
Slice 4	23.594771	135.08396	97.568835	1,091.3358	894.79175	0
Slice 5	29.947189	130.91409	284.64836	1,370.4614	977.67042	0
Slice 6	36.299607	126.99572	456.03362	1,618.6119	1,046.7902	0
Slice 7	42.652026	123.31618	612.51665	1,840.7432	1,105.9001	0
Slice 8	49.004444	119.8643	754.7933	2,041.1793	1,158.2672	0
Slice 9	55.356862	116.63025	883.47743	2,223.6139	1,206.6643	0
Slice 10	61.709281	113.60532	999.11242	2,391.0801	1,253.3334	0
Slice 11	68.061699	110.78178	1,102.1806	2,545.8951	1,299.9264	0
Slice 12	74.414117	108.15276	1,193.1108	2,689.5793	1,347.4263	0
Slice 13	80.766536	105.71214	1,272.285	2,822.7627	1,396.0564	0
Slice 14	87.118954	103.45445	1,340.0437	2,945.0899	1,445.1901	0
Slice 15	93.471372	101.37486	1,396.6899	3,055.1477	1,493.2821	0
Slice 16	99.823791	99.469017	1,442.4937	3,150.4432	1,537.8446	0
Slice 17	106.34537	97.691432	1,445.7904	3,215.205	1,593.1881	0
Slice 18	113.03612	96.047631	1,406.235	3,243.148	1,653.9639	0
Slice 19	119.72687	94.584995	1,355.3749	3,238.2269	1,695.3276	0
Slice 20	126.41762	93.300501	1,293.3988	3,193.3219	1,710.6985	0
Slice 21	133.10836	92.191551	1,220.4687	3,102.1296	1,694.2551	0
Slice 22	139.79911	91.255942	1,136.7222	2,959.9934	1,641.6807	0
Slice 23	146.48986	90.491845	1,042.2733	2,764.5999	1,550.7898	0
Slice 24	153.1806	89.897783	937.21417	2,516.3956	1,421.9013	0
Slice 25	159.87135	89.472623	821.61563	2,218.6132	1,257.8623	0
Slice 26	166.5621	89.215557	695.52799	1,876.8837	1,063.6974	0
Slice 27	173.25285	89.1261	558.98152	1,498.5028	845.94875	0
Slice 28	179.94359	89.204085	411.98673	1,091.5066	611.84239	0
Slice 29	186.63434	89.449658	254.53445	663.74829	368.45779	0
Slice 30	193.32509	89.863281	86.595783	222.1537	122.0569	0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APPENDIX E

SELECT PROJECT PLANS

BASIS OF BEARINGS: MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE

MATCH LINE

(SEE INSET)

CHURCH STREET (PUBLIC – VARIABLE WIDTH)

WEST STREET (PUBLIC – VARIABLE WIDTH)

BENCHMARK: TOP SPINDLE ON FIRE HYDRANT ELEVATION=449.92

BENCHMARK: (TEMPORARY BM) TOP HUB/TACK SET ELEVATION=461.69

BENCHMARK: (TEMPORARY BM) TOP SPIKE SET ELEVATION=485.18

CONSTRUCT 2'± HIGH NATURAL STONE FREE STANDING FARMER'S WALL WITH DISASSEMBLED FARMER'S WALL STONES ON SITE, WEATHERED/MOSS COVERED STONES TO BE PLACED ALONG TOP OF WALL

REMOVE & DISPOSE EXISTING DWELLING #1

REPLICATION AREA

CONTRACTOR TO EXECUTE EXTREME CARE WORKING IN THIS SENSITIVE AREA. SURFACE OF THIS AREA TO BE RESTORED TO CURRENT CONDITIONS. TEMPORARY ALTERATION AND RESORATION OF REPKLICATION AREA= 125± S.F.

ALIGNMENT BASELINE

ALIGNMENT CENTERLINE

LEVEL SPREADER

ECB- WATTLES & SILT FENCE

2:1 SLOPE STABILIZATION

EXISTING DWELLING #29 & #31

EXISTING DWELLING #33 & #35

EXISTING DWELLING #15

EXISTING GARAGE

BLDG-1 TOF 464.00 BFE 453.67

BLDG-2 TOF 470.50 BFE 463.17

BLDG-3 TOF 472.50 BFE 465.17

BLDG-4 TOF 475.00 BFE 467.67

BLDG-5 TOF 476.50 BFE 469.17

BLDG-6 TOF 477.50 BFE 470.17

BLDG-7 TOF 481.00 BFE 471.00

BLDG-8 TOF 488.00 BFE 480.67

BLDG-9 TOF 462.40 BFE 472.40

BLDG-10 TOF 489.33 BFE 482.00

BLDG-11 TOF 474.00 BFE 467.67

BLDG-12 TOF 475.00 BFE 467.67

BLDG-13 TOF 468.00 BFE 458.00

BLDG-14 TOF 468.00 BFE 458.00

BLDG-15 TOF 480.40 BFE 468.40

BLDG-16 TOF 473.40 BFE 462.40

DRIVE "A"

DRIVE "B"

WETLAND

RIPRAP PLUNGE POOL

RIPRAP SWALE

SEDIMENT FOREBAY

RIPRAP, EMERGENCY SPILLWAY

GRAVEL WETLAND (2 TREATMENT CELLS)

INFILTRATION BASIN

1.5:1 RIPRAP SLOPE STABILIZATION

DMH-1 … DMH-15, DMH-1A, DMH-1B, DMH-1W, DMH-2W, DMH-3W

DMH-1 (STU) … DMH-6 (STU)

CB-1 … CB-12

DI-1

ECB

FES-1 … FES-5

INF-1A, INF-1B

BASIN-1, BASIN-2

PIPE-2W

ECB- SILT SACK (TYP)

APPROXIMATE LOCATION OF DRAIN PIPE AS SHOWN ON PLAN OF LAND PREPARED BY BLACKSTONE VALLEY AND MAPPING DATED TO BE FIELD VERIFIED BY SITE CONTRACTOR

INSET MATCH LINE

APPROXIMATE LOCATION OF CONDO UNITS (TYP.) #65-#68

#57-#63

NOTTINGHAM ROAD

SEE SHEET GN1.00 FOR GENERAL NOTES AND LEGEND.

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THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNTIL ISSUED AS A CONSTRUCTION DRAWING BY WDA DESIGN GROUP.

CONDITIONALLY APPROVED
GRAFTON PLANNING BOARD

SIGNATURE	DATE
SIGNATURE	DATE
SIGNATURE	DATE
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REV.	DATE	DESCRIPTION	INIT.
B	5/17/19	PEER REVIEW & TOWN COMMENTS	
A		INITIAL ISSUE	

COMMONWEALTH OF MASSACHUSETTS
MICHAEL J. SCOTT
CIVIL
No. 40863
REGISTERED PROFESSIONAL ENGINEER

PREPARED BY:

WDA DESIGN GROUP
31 EAST MAIN STREET WESTBOROUGH, MA | 508.366.6552
WDA-DG.COM

OWNERS:
DAVID W. BROSSI
15 Juniper Lane
Grafton, MA 01519
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

PREPARED FOR:
BRIGATI VILLAGE, LLC
15 Juniper Lane
Grafton, MA 01519

TITLE:
GRADING AND DRAINAGE PLAN

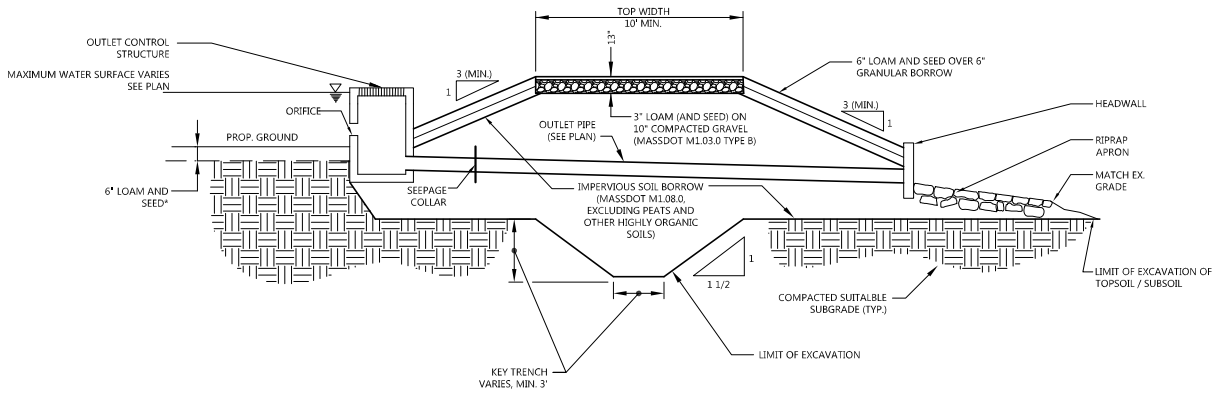
"BRIGATI VILLAGE"
41 CHURCH STREET/
14 WEST STREET
Grafton, MA
(Worcester County)

LOCAL PERMITTING

SCALE: 1" = 40'
0 40 80 120

JOB NO.:	1046.05	DATE:	02/07/19
DWN. BY:	JTA	SHEET:	C3.02
CHK'D. BY:	WMB		

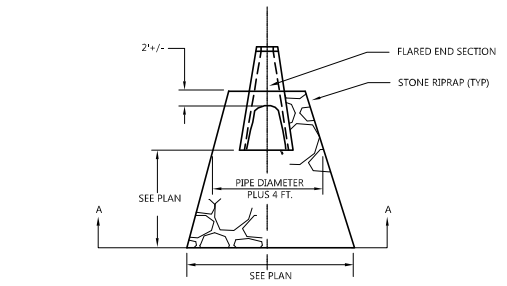
NOTES:
1. REMOVE TOP/SUBSOIL. SEED MIX TO BE MOISTURE TOLERANT GRASSES.
2. AFTER THE BASIN FLOOR IS SHAPED, PLACE SOIL ADDITIVES ON THE BASIN FLOOR TO AMEND THE SOIL. THE SOIL ADDITIVES SHALL INCLUDE COMPOST, PROPERLY AGED TO KILL ANY SEED STOCK CONTAINED WITHIN THE COMPOST. DO NOT PUT BIOSOLIDS IN THE COMPOST. MIX NATIVE SOILS THAT WERE EXCAVATED FROM THE A OR B HORIZONS TO CREATE THE BASIN WITH THE COMPOST, AND THEN SCARIFY THE NATIVE MATERIALS AND COMPOST INTO THE PARENT MATERIAL USING A CHISEL PLOW OR ROTARY DEVICE TO A DEPTH OF 12 INCHES, IMMEDIATELY AFTER CONSTRUCTING THE BASIN. STABILIZE ITS BOTTOM AND SIDE SLOPES WITH A DENSE TURF OF WATER-TOLERANT GRASS. USE LOW-MAINTENANCE, RAPIDLY GERMINATING GRASSES, SUCH AS FESCUES. THE SELECTED GRASSES MUST BE CAPABLE OF SURVIVING IN BOTH WET AND DRY CONDITIONS. DO NOT USE SOD, WHICH CAN PREVENT ROOTS FROM DIRECTLY CONTACTING THE UNDERLYING SOIL. DURING THE FIRST TWO MONTHS, INSPECT THE NEWLY ESTABLISHED VEGETATION SEVERAL TIMES TO DETERMINE IF ANY REMEDIAL ACTIONS (E.G., RESEEDING, IRRIGATING) ARE NECESSARY.



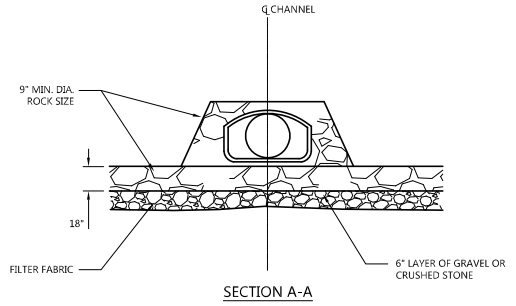
DETENTION BASIN BERM SECTION

N.T.S. 02600-27

WDA, INC.



PLAN

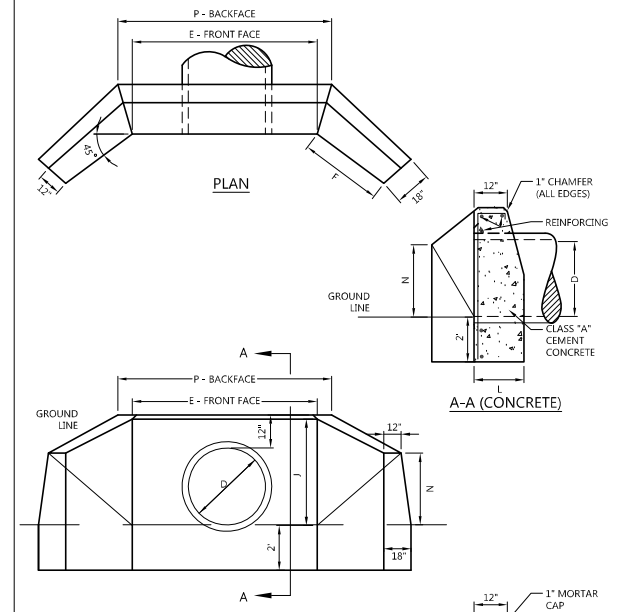


SECTION A-A

RIPRAP APRON

N.T.S. 02600-15

WDA, INC.



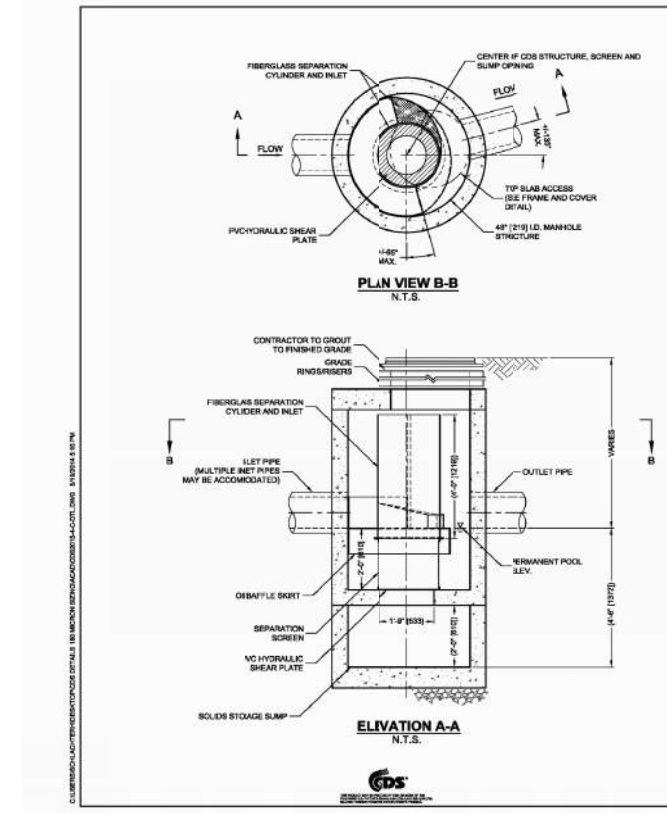
PIPE DIAM.	2 : 1 SLOPE					
D	E	P	J	N	L	F
≤ 30"	4'	5'-3"	3'-6"	2'	1'-6"	4'-3"
36"	4'-6"	5'-11"	4'	2'-3"	1'-8"	5'
48"	5'-6"	7'-2"	5'	2'-9"	2'	6'-6"
60"	6'-6"	8'-5"	6'	3'-3"	2'-4"	8'
72"	7'-6"	9'-9"	7'	3'-9"	2'-8"	9'-6"
84"	8'-6"	11'	8'	4'-3"	3'	11'

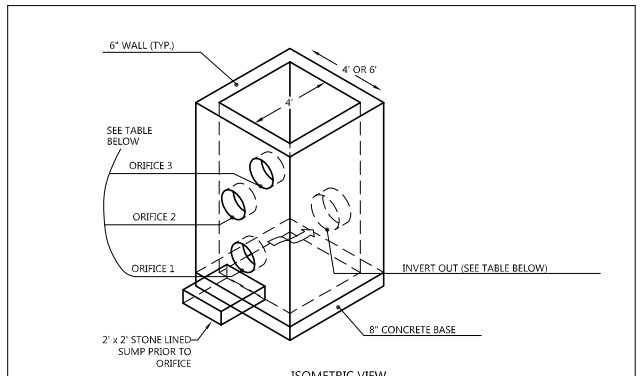
NOTES:
1. FOR DESCRIPTIONS, MATERIALS, AND CONSTRUCTION METHODS, SEE LATEST MHDSS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. ALL REINFORCING TO BE #3 BARS AT 12" EACH WAY (TYP.) WITH 1-1/2" CLEARANCE (MIN.).

HEADWALL WITH WINGWALLS (WW)

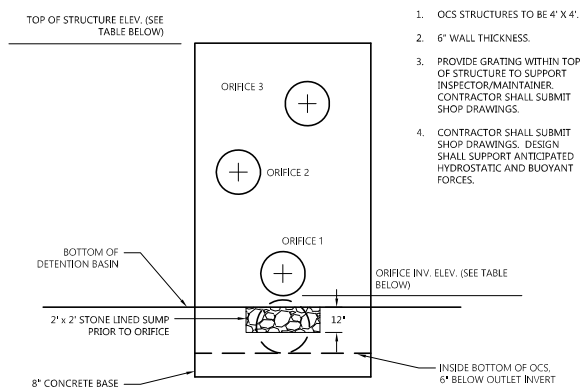
N.T.S. 02600-41

WDA, INC.





ISOMETRIC VIEW



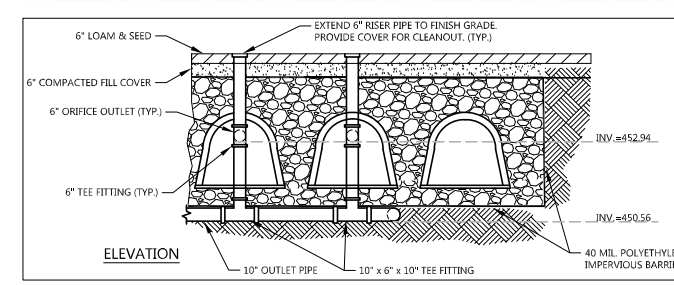
NOTES:
1. OCS STRUCTURES TO BE 4' X 4'.
2. 6" WALL THICKNESS.
3. PROVIDE GRATING WITHIN TOP OF STRUCTURE TO SUPPORT INSPECTOR/MAINTAINER. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS.
4. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS. DESIGN SHALL SUPPORT ANTICIPATED HYDROSTATIC AND BUOYANT FORCES.

OCS #	ORIFICE 1 SIZE (INCHES)	ORIFICE 1 ELEV.	ORIFICE 2 SIZE (INCHES)	ORIFICE 2 ELEV.	ORIFICE 3 SIZE (INCHES)	ORIFICE 3 ELEV.	OUTLET SIZE (INCHES)	OUTLET INVERT ELEV.	TOP OF STRUCTURE ELEV.
1	4"	446.75	6"	451.50	N/A	N/A	18"	446.0	451.95
2	4"	452.85	3 x 10"	453.95	N/A	N/A	18"	449.90	454.40
3	4"	465.30	6"	467.00	6"	468.80	18"	464.0	469.50

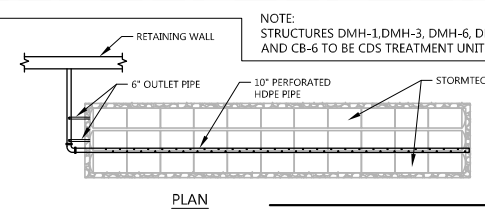
OUTLET CONTROL STRUCTURE (OCS)

N.T.S. 02600-14

WDA, INC.



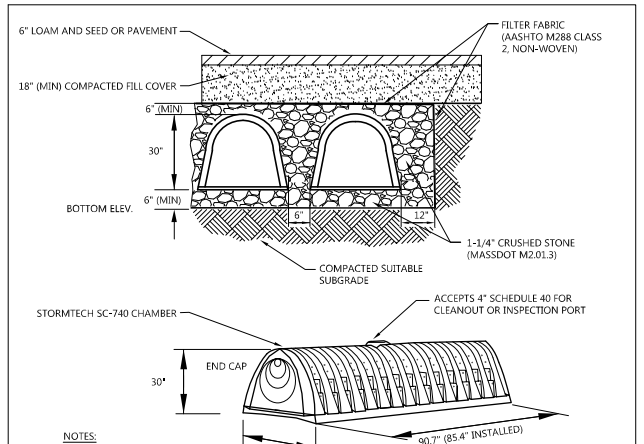
NOTE:
STRUCTURES DMH-1,DMH-3, DMH-6, DMH-9,DMH-12, AND CB-6 TO BE CDS TREATMENT UNITS.



DB-4 OCS CONFIGURATION

N.T.S.

WDA, INC.



NOTES:
1. REQUIRES H-20 LOADING.
2. "STORMTECH SC-740" BY INFILTRATOR SYSTEMS, OR EQUAL AS APPROVED BY THE ENGINEER.
3. INSTALLATION IS TO BE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
4. PROVIDE CLEANOUTS/INSPECTION PORTS ON ALTERNATING ROWS AT 50' INTERVALS.

SYSTEM DESIGNATION	BOTTOM ELEV.	INVERT ELEV.	# OF ROWS	WIDTH OF STONE	# OF UNITS/ROW	LENGTH OF STONE	TOTAL # OF UNITS
DB-4	450.90	452.94	3	16.75'	11	83'	33
INF-1 (A)	474.50	476.54	2	12.5'	2	18'	4
INF-1 (B)	472.00	474.04	2	12.5'	2	18'	4

STORMWATER INFILTRATION SYSTEM (INF)

N.T.S. 02600-12-STORMTECH

WDA, INC.

CONDITIONALLY APPROVED
GRAFTON PLANNING BOARD

SIGNATURE DATE
SIGNATURE DATE
SIGNATURE DATE
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A		INITIAL ISSUE	

COMMONWEALTH OF MASSACHUSETTS
MICHAEL J. SCOTT
CIVIL
No. 40363
REGISTERED PROFESSIONAL ENGINEER

PREPARED BY:
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31 EAST MAIN STREET WESTBOROUGH, MA | 508.366.6552
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BRIGATI VILLAGE, LLC
15 Juniper Lane
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PREPARED FOR:
BRIGATI VILLAGE, LLC
15 Juniper Lane
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TITLE:
DETAILS

"BRIGATI VILLAGE"
41 CHURCH STREET/
14 WEST STREET
Grafton, MA
(Worcester County)

LOCAL PERMITTING

JOB NO.:	1046.05	DATE:	02/07/19
DWN. BY:	CMP	SHEET:	C5.04
CHK'D. BY:	WMB		

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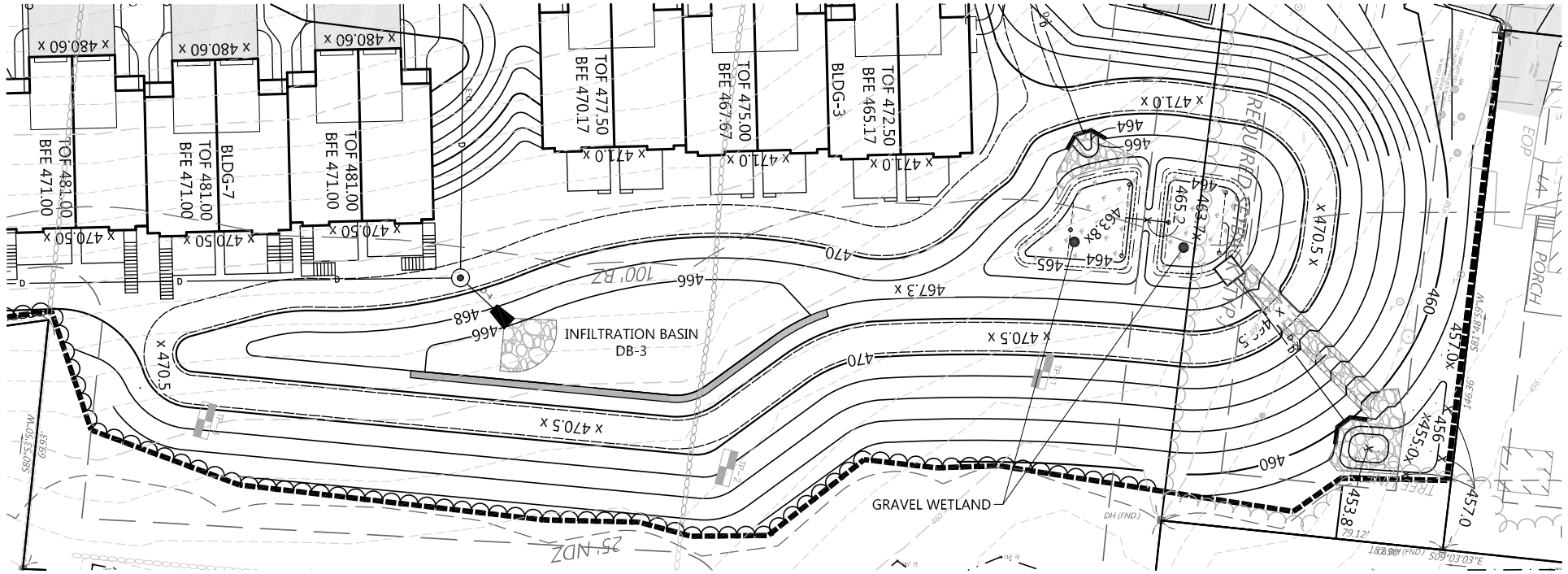


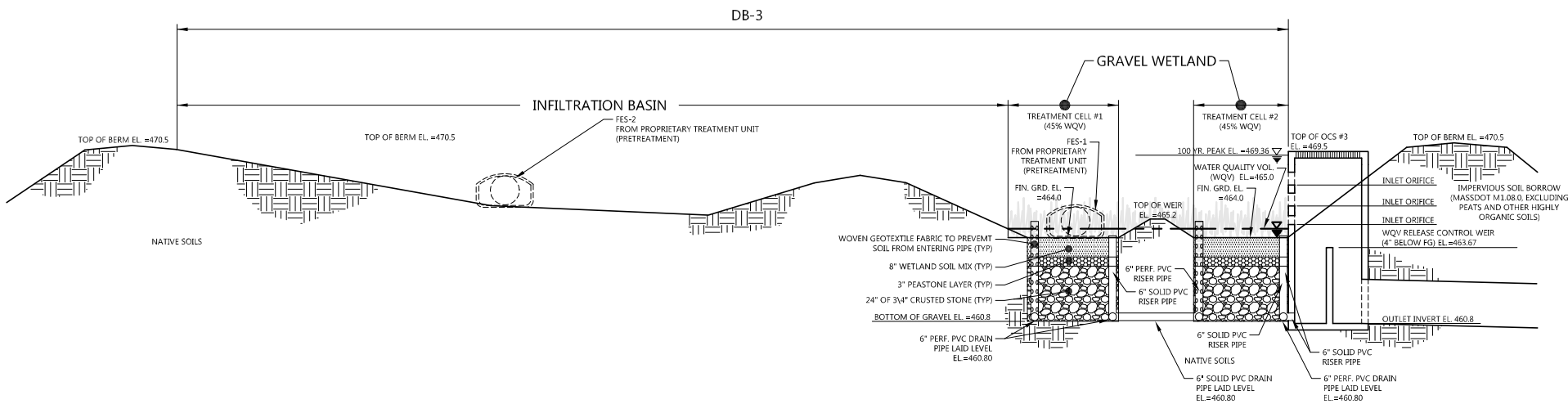
PLAN

DETENTION /INFILTRATION BASIN NOTES:

1. REFER TO DETENTION BASIN BERM SECTION.
2. REMOVE TOP/SUBSOIL. SEED MIX TO BE MOISTURE TOLERANT GRASSES.
3. AFTER THE BASIN FLOOR IS SHAPED, PLACE SOIL ADDITIVES ON THE BASIN FLOOR TO AMEND THE SOIL. THE SOIL ADDITIVES SHALL INCLUDE COMPOST, PROPERLY AGED TO KILL ANY SEED STOCK CONTAINED WITHIN THE COMPOST. DO NOT PUT BIOSOLIDS IN THE COMPOST. MIX NATIVE SOILS THAT WERE EXCAVATED FROM THE A OR B HORIZONS TO CREATE THE BASIN WITH THE COMPOST, AND THEN SCARIFY THE NATIVE MATERIALS AND COMPOST INTO THE PARENT MATERIAL USING A CHISEL PLOW OR ROTARY DEVICE TO A DEPTH OF 12 INCHES. IMMEDIATELY AFTER CONSTRUCTING THE BASIN, STABILIZE ITS BOTTOM AND SIDE SLOPES WITH A DENSE TURF OF WATER-TOLERANT GRASS. USE LOW-MAINTENANCE, RAPIDLY GERMINATING GRASSES, SUCH AS FESCUES. THE SELECTED GRASSES MUST BE CAPABLE OF SURVIVING IN BOTH WET AND DRY CONDITIONS. DO NOT USE SOD, WHICH CAN PREVENT ROOTS FROM DIRECTLY CONTACTING THE UNDERLYING SOIL. DURING THE FIRST TWO MONTHS, INSPECT THE NEWLY ESTABLISHED VEGETATION SEVERAL TIMES TO DETERMINE IF ANY REMEDIAL ACTIONS (E.G., RESEEDING, IRRIGATING) ARE NECESSARY.

GRAVEL WETLAND NOTES:

1. REFER TO DETENTION BASIN BERM SECTION.
2. CROSS SECTION IS SCHEMATIC ONLY AND IS INTENDED TO ILLUSTRATE THE FLOW PATH OF WATER THROUGH THE SYSTEM.
3. SOIL COMPOSITION SHALL BE APPROVED BY THE PROJECT WETLANDS SPECIALIST. SOIL SHALL BE CLEAN LEAF COMPOST OR 50/50 MIX OF CLEAN LOAM AND PEAT MIX, SUBSTITUTIONS BY APPROVAL OF WETLAND SPECIALIST OR CONSERVATION COMMISSION.
4. VEGETATE GRAVEL WETLANDS WITH A NEW ENGLAND WETLAND SEED MIX (GRASSES) BY NEW ENGLAND WETLAND PLANTS, INC. APPLY AS SPECIFIED BY DISTRIBUTOR.
5. PLANTING OF VEGETATION WITHIN THE GRAVEL WETLAND SHALL BE PERFORMED UNDER THE SUPERVISION OF THE WETLAND SPECIALIST.
6. GRAVEL WETLAND MAY REQUIRE SUPPLEMENTAL SEEDING, AND A STRAW COVER DEPENDING ON SEASONAL AND SITE CONDITIONS. PRIOR TO SPREADING SEED, THE WETLAND SPECIALIST OR THE CONSERVATION COMMISSION SHALL APPROVE THE SEED MIX. IF A SUPPLEMENTAL WATERING PROGRAM IS TO BE EMPLOYED UNTIL THE AREA BECOMES ESTABLISHED, THE WATERING REGIME AND RESPONSIBLE PARTY SHALL BE APPROVED BY THE WETLAND SPECIALIST.
7. THE GRAVEL WETLAND SHALL BE INSPECTED PERIODICALLY BY THE WETLAND SPECIALIST OR THE CONSERVATION COMMISSION AND ANY ADDITIONAL WORK OR MAINTENANCE SHALL BE ADDRESSED AS NOTED.
8. AT LEAST 75 PERCENT OF THE GRAVEL WETLAND SHALL BE ESTABLISHED WITH DESIRABLE WETLAND PLANT SPECIES WITHIN TWO GROWING SEASONS (PER 310 CMR 10.55(4)(b)(6.).
9. SECONDARY HYDRAULIC INLET SHALL BE A 6-INCH PERFORATED HDPE PIPE. THE PORTION OF THE PIPE LOCATED IN THE WETLAND SOIL MIX LAYER SHALL BE WRAPPED WITH WOVEN GEOTEXTILE FABRIC TO PREVENT SOIL FROM ENTERING THE PIPE.



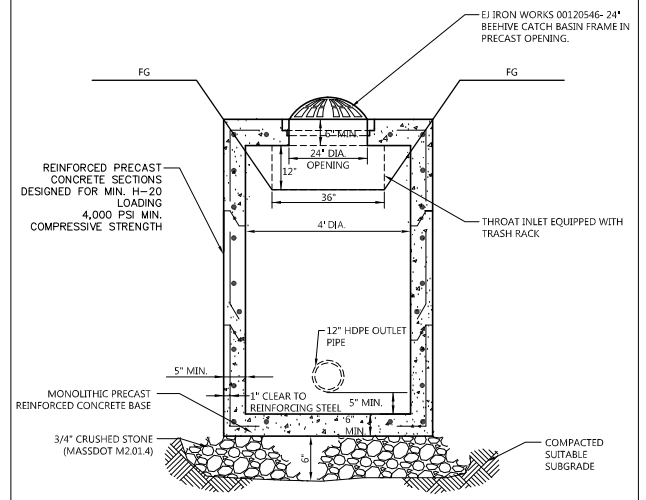
SECTION

INFILTRATION DETENTION BASIN / GRAVEL WETLAND DETAIL

N.T.S. 02600-27X

WDA, INC.

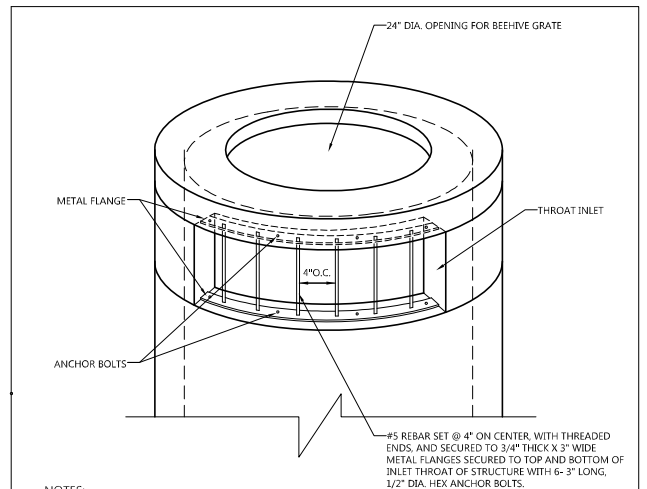
NOTES: 4" DIA. – PIPE PENETRATIONS TO 24"
5" DIA. – PIPE PENETRATIONS TO 30"
6" DIA. – PIPE PENETRATIONS TO 42"
8" DIA. – PIPE PENETRATIONS TO 60"



4' DIAMETER DROP INLET (DI-1)

N.T.S. 02600-01DI

WDA, INC.



NOTES:

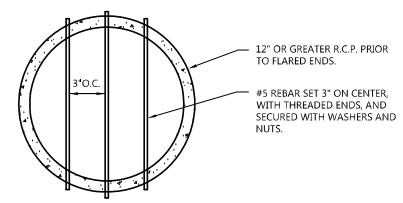
1. REFER TO DROP INLET DETAIL FOR INLET THROAT AND STRUCTURE DIMENSIONS AND MATERIALS.

ISOMETRIC VIEW

DRAINAGE SAFETY/ TRASH GRATE (DI-1)

N.T.S. 02600-19DI

WDA, INC.



DRAINAGE SAFETY GRATE

N.T.S. 02600-19

WDA, INC.

CONDITIONALLY APPROVED
GRAFTON PLANNING BOARD

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